QUARTERLY JOURNAL FOR TEACHERS OF SCIENCE IN THE CATHOLIC HIGH SCHOOLS

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The SCIENCE COUNSELOR

olume VI ★ Number 4 ★ Dec., 1940

DUQUESNE UNIVERSITY PRESS

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			LOWER PART ONLY					
			6	2.50	13.50	12.83	12.15	11.48
			COVER ONLY					
			12	1.35	14.58	13.85	13.12	12.39
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			4	$7.50	$27.00	$25.65	$24.30	$22.95
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Science Conference Postponed . . .

Because of the uncertain international situation, and the unpredictable changes in our national life that may come within the next few months, Duquesne University has decided, reluctantly, not to hold in February, 1941, its annual Conference for teachers of science in Catholic high schools. Both the University and the Director of the Conference regret that this action must be taken. They hope that through some fortunate combination of circumstances the situation will improve sufficiently that the Conference can be held later in the year. If this should be possible, advance announcement will be made in due time.

The hundreds of teachers who have attended the Conferences in the past will regret the cancellation of the ninth annual meeting. We shall try to see, however, that some of the inspiration and help that they have been accustomed to derive from the meetings will come to them through the pages of the *Science Counselor*.

Since the Conference will not be held in February, as announced in our September issue, there will be *no exhibit of student project material*. Schools which have been preparing displays should complete them and hold them for the next Conference.

Science Essay Contest will be Held

According to the rules of the contest the essays on the assigned topic must be received not later than February 1, 1941. Awards will be made in the usual way, and the announcement of the winners will appear in the March or June issue. ●

The Bulletin Board as a Student Activity

● **By Ernest B. Wilson, M. S.** *(University of Georgia)*

DEPARTMENT OF CHEMISTRY, ERASMUS HALL HIGH SCHOOL, BROOKLYN, N. Y.

No teacher can afford to miss reading this practical, down-to-earth, and really helpful article that is based upon the personal experience of the writer. It describes a teaching method that every teacher can use if he cares to do so.

Money is not involved. Neither is a great deal of time necessary. Only a real interest in pupils, a knowledge of subject matter, and the enthusiasm that every real teacher always has on tap, are required.

Why not try this plan? It comes from a school that claims to be the oldest academy in the United States, and, consequently, the first school chartered for high school work.

●

A bulletin board may be a valuable means of stimulating student interest in a given science. But in discussing this type of activity we are not concerned with the usual kind of bulletin board used for posting announcements. In fact, the ordinary board is much too small for the best application of the method we are proposing.

Unless a very large board is available, one should be constructed. If space permits, the board should be four or five feet wide and eight to twelve feet long. Materials are inexpensive and easy to secure. Lumber dealers or mail order houses can supply half-inch laminated panel board of the dimensions required. The panel board may be covered with celotex insulation, heavy cardboard, or thick roofing felt that will take thumb tacks. The panel board is heavy enough to take small nails.

If the board is covered with ordinary paper, which can be replaced from time to time, the dirty and dusty appearance frequently presented by old bulletin boards will be avoided. Attention may be drawn to the board by covering it with paper colored red, blue, green, etc. This has much the same appeal that new furniture covers have. The board should be placed in as conspicuous a location as is available. A position opposite an entrance, a ninety degree turn in a hall, or the landing of an ascending stairway will be suitable if there is sufficient light.

When the instructor is ready to inaugurate the activity, usually at the beginning of the term, he selects several topics from those listed in the course of study. The chemistry instructor may choose copper, aluminum, alcohol, petroleum, cellulose, or similar topics. Generally, each topic will be divided into sections such as theme, history, occurrence, manufacturing processes, location of important commercial centers, and applications of various kinds. After subdividing a topic, the instructor makes a tentative plan allotting a definite space to each subdivision. He prepares a scale drawing which locates each section on the board.

The matter is now presented to the student group, and the plan discussed. Volunteers who will be responsible for a section are requested. When the desired number of volunteers has been obtained, a conference is called to parcel out the various sections. This conference is important because an effort must be made to assign a given section to the student who has the most aptitude for it or to the one with the best access to samples or photographs. For example, a student who has had experience in drawing letters is needed to prepare the title for the topic.

At the conference each student is supplied with a piece of cardboard cut to the dimensions allotted to his section. The top, bottom, and reading order of his section are marked on the cardboard. The scale drawing is shown to each student and the part that his section will play in the completed board is carefully explained. If the above precautions are taken, each student may now proceed to develop his section at home without fear of having it fail to fit when the sections are assembled.

The location of the various sections on the board should be as attractive as possible. Much will depend on the nature and amount of material available. Close supervision by the instructor is necessary for the best results. He should not hesitate to reject unattractive, unnecessary, or excess material. Usually the following sequence can be used. The upper six inches of the board are reserved for the title of the topic. A theme section about two feet square is placed in the center immediately under the title strip. History, occurrence, and raw material are placed to the left of the theme, and manufacturing processes to the right. A map of the commercial centers may be placed under the theme section. Applications of the substance featured are placed in the remaining space.

This arrangement enables the observer, who is attracted to the board by the title or theme section, to begin studying the topic in the upper left corner and continue across the board as if it were a page from a book. However, each topic presents a special problem and the students participating must decide upon the best arrangement. This is done in conference, and the decision is subject to the instructor's approval, of course.

In a recent display on the topic of copper, the theme section was a piece of bright sheet copper about two feet square. This copper sheet attracted passing students and visitors because of its mirror-like qualities.

Continued on Page One Hundred and Nineteen

How Ancient Timbers Gave Clues To Long-sought Dates

● **By Dr. Emil W. Haury.**
DEPARTMENT OF ANTHROPOLOGY, UNIVERSITY OF ARIZONA, TUCSON, ARIZONA

Trees can tell time!

Surprising, but true.

Through a study of the annual growth rings in ancient timbers it is possible to identify the century in which the tree from which the timber came, lived.

This paper, sponsored by the National Park Service, United States Department of the Interior, tells how the work is done.

●

One summer day just ten years ago I was standing on the edge of an excavation in a ruin situated at Showlow, Arizona, watching a workman carefully wrapping the charred end of what was once a roof timber of a pueblo occupied by native Americans before the arrival of the Spaniards. This precaution of winding the charred beam with string was necessary to keep the fragments from falling apart. It seemed wholly incredible that there could be any value whatsoever attached to this very unattractive bit of burned wood consumed by a fire no one knew how long ago. But the events which followed this discovery in quick succession soon erased all doubts as to the significance of the log.

Dr. A. E. Douglass, then Director of Steward Observatory at the University of Arizona, was present at Showlow at the time. After examining the scrap of the log he felt sure that it could tell an important story. On the evening of that day several of us gathered around a small table to look on while Dr. Douglass made a final and thorough check of the story told in the annual growth rings of this log. After a long study he finally concluded that the tree from which this roof timber had been made was cut in the last decade of the fourteenth century and that the tree had started growing in the early decades of the thirteenth century. The immediate importance of this conclusion was apparent only to Dr. Douglass since, through years of painstaking labor, he had succeeded in building a calendar based on the annual growth of rings which extended from the living trees of today backwards in time to the fourteenth century.

Inspection of innumerable roof timbers from the ruins in the southwestern United States, such as the cliff dwellings of Mesa Verde and Arizona, and Pueblo Bonito of New Mexico, had given him a chronology over five hundred years long, which was floating and could not be connected with the record of living trees. The Showlow log made it clear for the first time just how this series of rings, known to be older than 1400 A.D., connected with the historic sequence. And so it was with great satisfaction that Dr. Douglass could tell the small group assembled at Showlow just how old Pueblo Bonito and the other ruins actually are in terms of our Christian calendar.

The discovery that trees could be used in the southwestern United States to tell time came after delving into an astronomic phenomenon and after making patient and trying studies of trees themselves. Dr. Douglass' early interests in astronomy centered about sunspots, their cyclic occurrence, and their effect on the earth's weather. If sun-spots affected our weather, either by producing more or less moisture, or perhaps affecting it even in other ways, he reasoned that there should be some evidence of this fact in living things. As trees are the earth's oldest living occupants, he turned to them as a possible source of information. Naturally, it was important in this study to find old trees, for the longer the record of annual rings, the farther it would be possible to look backward in time to climatic effects.

This work started in 1901, and it was not until 1915 that the idea was first conceived of using timbers in ancient ruins. Here there immediately arose the possibility of an extremely useful by-product of an astronomic study, for if timbers from ruins could be made to fit into a tree-ring calendar, rooted in the current year, the actual age of the ruins themselves could be told. Such an achievement would be the answer to every archaeologist's prayer. Not until 1929, however, did Dr. Douglass' system meet with wholesale success, beginning that evening in the little Mormon settlement of Showlow.

Since that time progress in dating ruins has moved apace, both through Dr. Douglass' own efforts and those of students trained by him in the science of dating. At the present time well over two hundred of the Southwest's ruins have been quite accurately placed in the time scale ranging from the middle of the fourth century A.D. to the early historic period. Nor is this all. For Dr. Douglass' students have carried his system beyond the limits of the southwestern United States and are now applying it in dating the remains of early Americans in the eastern and southeastern portions of the country.

The actual process of dating is not easy and demands, first of all, patience and a knowledge of tree growth. The southwestern United States enjoys, during the course of each year, two rainy seasons—one in winter when slow rain soaks the lowlands and snow falls in the higher altitudes. Much of the moisture thus derived sinks into the ground where it is available to trees. The second rainy season comes during the height of summer

when the country is drenched by local downpours lasting only a few minutes. Most of this water runs off, thus being of little importance in tree growth. It follows, then, that in times of abundant winter rainfall or snowfall, the tree will have access to more moisture stored in the ground and will grow more abundantly, and that in times of scanty rainfall there will be little growth. If there is any doubt that moisture is an important item in the life of trees and most plants, one needs but look at a backyard garden to see the vegetables wither when they do not receive water, or to observe trees fail in one's own yard when they are deprived of moisture. Other factors, of course, enter into tree growth such as the nature of the soil in which the tree is rooted, altitude, early and late frosts, ultraviolet radiation, *et cetera*. But these for the moment are not particularly important to our present field of interest.

Dating trees in the Southwest is further made possible because the rainfall is not the same from year to year; some years are considerably wetter than others. Looking at any series of rings, then, one should see a pattern of large, intermediate, and small rings—giving what Douglass has referred to as the "tree's fingerprint." If the moisture were constant year to year, each ring would be approximately as large as its predecessor and one could do little more than tell the age of the tree. Since it is the winter rains and snows which are largely responsible for the size of a tree's rings and these winter storms are of a general nature, it follows that all trees growing in similar environments should register an abundance or a lack of moisture in the same way. On this basis rests one of the important angles of tree-ring dating, namely the ability to match the record of one tree against that of another.

So long as any two or more trees of equal age are compared against each other nothing is gained in building a chronology. But when trees of unequal age, overlapping partly in time, are compared against each other, it is possible to construct what is known as a tree-ring chronology. Perhaps it will be well to illustrate this with an example.

Suppose that a tree springs up in the forest and is permitted to grow unmolested for a hundred years. At the end of that time another seedling sprouts beside it and these two trees continue growing for another hundred years. At that time the older of the two trees is cut for lumber, the younger tree continuing growth for a century, when it, too, is felled. Now, in examining the stumps it will be found that the ring pattern of the first tree during the last century of its growth will agree, or what is commonly known as "cross-date." This century which the two trees had in common serves to tie the ring records together to form a single three hundred year series although each tree was only two hundred years old when cut.

By applying this principle on a large scale, beginning with living trees and shingling back, as it were, with older and older material obtained from ruins, Dr. Douglass has built a tree-ring calendar which falls just short of two thousand years, and at the same time he has given the archaeologist the basis for an outline of human history which is unique in the world. It is little wonder, then, that the archaeologist pays as much attention today to scraps of wood or charcoal which he finds in his ruins as he does to pottery, basketry, stone implements, and textiles, for from this lowly material is derived information on that all important factor—time.

Tree-ring dating would be of little use in the American Southwest were it not for two fortunate circumstances. First, in the higher altitudes, mainly above 6,000 feet above sea level, the forest is made up principally of western yellow pine and, in still higher elevations, of Douglas fir. Below 6,000 feet one finds a tree which produces the edible pine-nut, commonly known as pinon. These three conifers have shown themselves to be of principal use in dating because they stand dormant during the winter months, resulting in a complete stoppage of growth which is marked by a sharp line of thick red cells in a tree's rings. This enables the student of "tree time" to pick out one ring from another—a characteristic which is not so strongly marked in many of the deciduous trees which grow in lower elevations of the Southwest. Second, the native population occupying a large part of Arizona, New Mexico, Colorado, and Utah developed a style of architecture which called for the use of large ceiling beams supported by masonry walls, and rooms built side by side and in tiers above each other. We see this style surviving today in modern pueblos such as the apartment houses of the Hopi, Zuni, and Rio Grande pueblos. This advancement in architecture coupled with the dry climate and the fact that many of the dwellings were built under the protecting cliffs provided by nature has resulted in the preservation of large quantities of the architectural wood which, in wetter climates, would have disintegrated to dust years ago.

Let us now accompany an archaeologist to a cliff ruin to see how the tree-ring method is actually applied. The ruin in question consists of approximately sixty rooms arranged compactly in two stories under the overhanging edge of a cliff. The walls still stand twenty feet high in spots and in several instances the roofs of both first and second story rooms are still intact. On every hand one sees an abundance of large pine timbers, sometimes as much as a foot in diameter. A number of these still occupy the original positions in which they were placed by the builders; others have been torn out of wall sockets by the spreading and collapse of walls. Here, then, lies a very fertile field for the student of tree-rings to take his samples for careful inspection in the laboratory.

The archaeologist carries in his kit a saw and a tubular borer, an instrument devised to extract a small core of wood extending from the outside to the center of a beam. First of all, our collector of wood removes small v-shaped cuts from the ends of all logs which are down, then extracting the cores with the borer from beams which are still supporting roofs—keeping in mind all the while the precaution to make his cuts or extract his cores from places where the holes will least

Continued on Page One Hundred and Fifteen

New Developments in Aluminum Alloys

● **By Palmer Kalsem**

DEPARTMENT OF PUBLIC RELATIONS, ALUMINUM COMPANY OF AMERICA, PITTSBURGH, PA.

It is a truism that the familiar is seldom appreciated at its real value. This holds good in the case of aluminum. We take this metal for granted, probably because it touches our lives pleasantly in so many ways. Consequently, few persons not connected with the industry are aware of the many new uses for aluminum, especially in the form of alloys.

Here is a story of intelligent commercial development founded on scientific research. Coming as it does from the aluminum industry itself, its information is accurate and up to the minute. It will give you new ideas.

●

All the aluminum produced in a day in this country in 1888 could have been hauled out in a wheelbarrow. Fifty pounds of metal represented a good day's work. Today, however, it is possible to make a million pounds of aluminum in a single day and, in 1939, a record production of more than 327 million pounds was reached.

From a jewelry metal, made only into trinkets and novelties, aluminum has in this short period become a standard metal of construction with thousands of applications. It is made into products as widely different as airplanes and miner's lamps; vacuum cleaners and chemical processing tanks; streamline buses and instrument wire one twenty-fifth the diameter of a human hair.

Back of aluminum's rapid development during this time there lie twelve major useful qualities, as well as a number of a secondary nature. Though perhaps best known for its light weight, aluminum is not used for this property alone. Rather it is a happy combination of several qualities—such as light weight and strength and durability, or light weight and resistance to corrosion and appearance—that give aluminum its unique place among the metals.

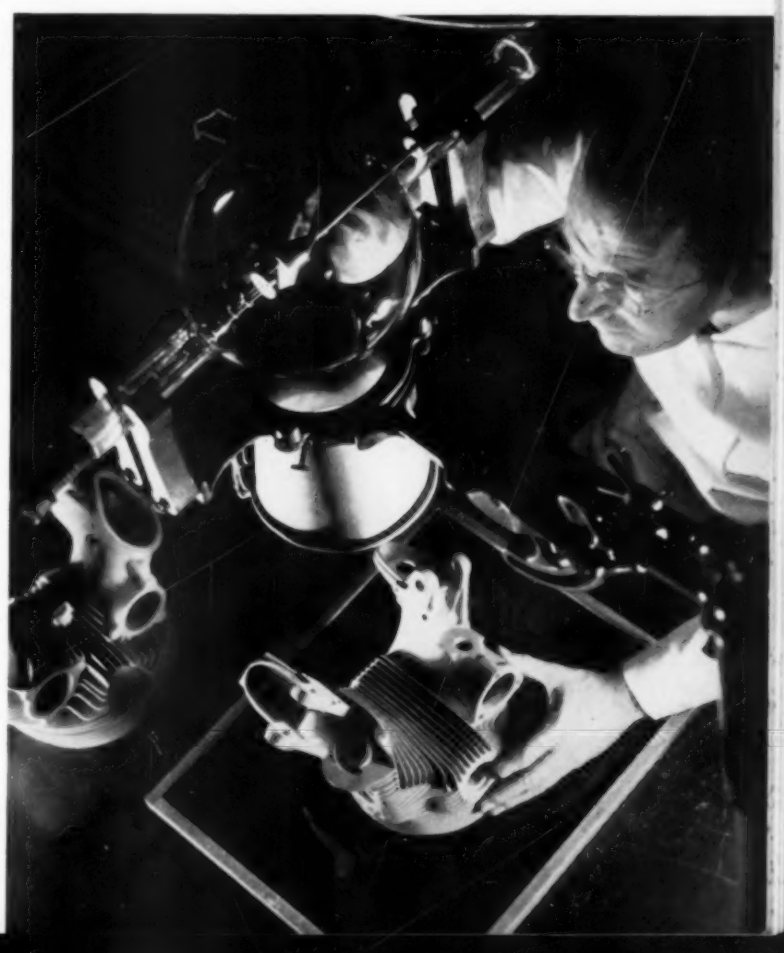
Other attributes include ease of fabrication; ability to be finished attractively, and reflectivity for light, which reaches its ultimate in Alzak-processed lighting reflectors. Then, too, the heat conductivity of the metal, its high scrap value, and the fact that aluminum is non-toxic, non-sparking, and non-magnetic, influence its use for many different types of products.

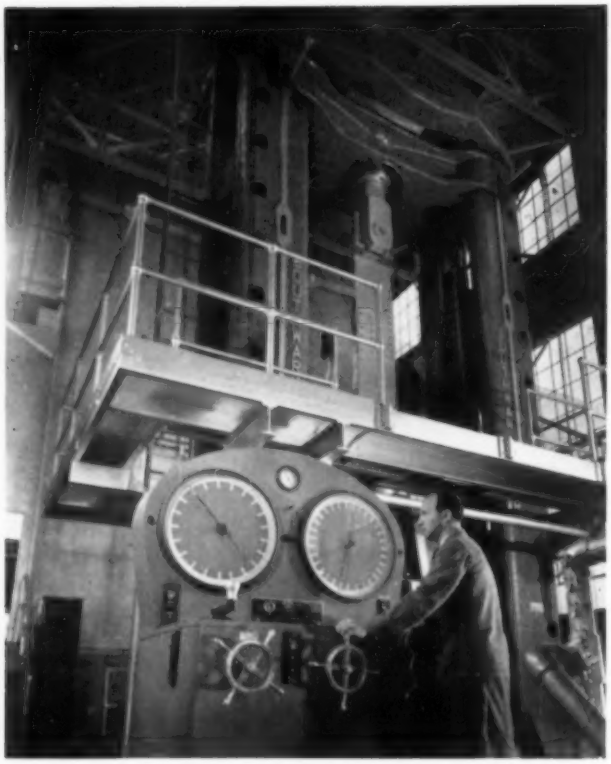
Lightness has not always been sought by the transportation industry, but today it ranks with streamlining in the minds of designers. The first streamline aluminum alloy train was built in 1934 for the Union Pacific. The eleventh and the twelfth were put in operation March 10, 1940, on Missouri Pacific's St. Louis-Kansas City-Omaha daytime run. A streamlined all-aluminum subway car, introduced on New York's Brooklyn-Manhattan Transit Company line in 1939, may be the beginning of a new era in subway car construction. Because of its light weight, this car makes as good time running as a local as conventional cars do on express runs.

Buses, too, have changed to light-weight streamlined construction, and aluminum has become the main structural material for both the luxurious transcontinental buses and the smaller interurban types. This year, 400 streamlined all-aluminum buses are being built by Yellow Truck and Coach for the Greyhound Company. With the adoption of modern air conditioning and diesel engines, bus manufacturers are using even more light-weight aluminum to compensate for the added dead weight.

Aluminum has always been known as the metal that flies best. In the midst of the aviation boom, there is an ever increasing need for material that is not only light, but strong and durable. Aluminum alloys of the heat-treated type continue to fulfill this need, and are used in both commercial and military aircraft. Remarkable strides have been made in transcontinental and trans-oceanic travel using aluminum airplanes.

Testing an aircraft sand casting by X-ray.





The world's most powerful testing machine now in operation at Aluminum Research Laboratories.

New equipment has been placed in service in anticipation of the requirements of the aviation industry. An example is a press for making corrugated aluminum for airplane wings requiring great rigidity. Also, the nation's largest forming hammer, recently installed at the Cleveland works of Aluminum Company of America, is resulting in improved airplane propellers, engine crankcases and landing gear.

Truck bodies of aluminum, once entirely custom-made, and now sold "off the shelf," afford an excellent example of the economy of light weight. One user of highway truck trailers made 20 aluminum units do the work of 25 units of older, heavier design. Aluminum pistons have long been used in truck and automotive engines, but in the past year the development of aluminum alloy automotive bearings, after years of research, was announced. These are expected to provide the nation's trucks and automobiles with longer life and better performance.

Less well-known than the transportation uses of aluminum is its service in rapidly moving parts of industrial machines for packaging, can making, computing, printing, carpet making and textile manufacture. When the feed slide bar of a high-speed can-making machine was made of aluminum, its capacity was increased from 350 to 450 cans per minute.

Since they have a long life and cost less to ship to the motorist, aluminum license plates are being used in both Arkansas and Connecticut. In Connecticut, the plates are of a permanent type and are in their fourth year of successful service.

In view of the disastrous floods of the past few years, attention of hydraulic engineers has been concentrated on flood-protection measures. Aluminum bulkheads, or portable flood gates, are used because they can be readily handled with a minimum of time, trouble and power expense.

In some fields, such as architecture, aluminum is used, not for its light weight, but because it resists corrosive influence of the atmosphere and can be attractively finished. Many homes, both large and small, are being equipped with aluminum windows, which are a relatively recent development. The new Criminal Courts Building in New York City, being built this year, will alone require 800,000 pounds of aluminum for architectural purposes. On the plant buildings of the Tennessee Valley Authority, aluminum is specified wherever a decorative metal is required.

A durable metal is also needed in the fast-growing rayon industry, because acid and acid fumes are highly corrosive and the corrosion products of many metals ruin the rayon yarn. Here aluminum buckets, spools, traverse bars, ducts, piping and cooking equipment are becoming commonplace.

When taken on the weight basis, aluminum is the best commercial conductor of electricity. This explains why more than 100,000 miles of aluminum cable, steel-reinforced, went into lines of the REA last year. The total of such cable that has been put in service now exceeds 900,000 miles. A promising new use is co-axial cable, and as television progresses, this is expected to become of increasing importance.

Refrigerating equipment requires material with a high conductivity for heat, a property for which aluminum is well known. Frozen food plates, in heavy gauges, are made from aluminum for the same reason. So are leg-shaped drying forms, used in the hosiery industry. When the hose slips off the form, it is ready for pack-

Continued on Page One Hundred and Seventeen

These aluminum alloy outboard motor gasoline tanks are being assembled by means of the new and efficient brazing process.

SILVERING GLASS. A Project

● **By Sister Virginia Heines, S.C.N., M.S.** *(St. Louis University)*

DEPARTMENT OF CHEMISTRY, NAZARETH COLLEGE, NAZARETH, KY.

Every teacher has been disappointed occasionally by laboratory projects that "don't work" in the hands of students. Here is one that will work. It should, for Sister Virginia took the trouble to obtain the original formula from a manufacturer of mirrors.

She says: "Even with the best directions the silvering process does not always work out in the laboratory. This is a commercial method and works like a charm. We think other science teachers will like to have it."

The Editor thinks so, too.

●

Historical

It is not known when mirrors were invented. Probably the reflecting surfaces of the still waters of lakes and pools were the first mirrors used by man. Those of Biblical times were made of metal. We read in Pentateuch[1] that brass mirrors were used by the Hebrews. Pliny[2] mentions that the ancients drank from vessels highly polished inside so as to reflect the face, and that gold foil[3] was applied behind glass. The latter[4] must have been made by the famous glass shops of Sidon.[5] Etruscan mirrors,[6] showing fine workmanship were found in the ruins of Praenecte. Roman mirrors from Pompeii are square, while those discovered at Corinth consist of metallic discs, polished and silvered on the surface. In the British Museum[7] is a mirror from Corinth representing Pan playing at the game of "Five Stones" with a Nymph attended by Eros; another is of Archaic art (500 B.C.), and there is a specimen from Cornwall as well.

The method of backing glass with sheets of metal to make mirrors was well known in the Middle Ages, at a time when steel and silver mirrors were almost exclusively employed. Vincent of Beauvais, writing about 1250, says that mirrors of glass and lead were the best of all: "*quia vitrum propter transparentiam melius recipit radios.*" The making of mirrors commercially developed in Venice. This city held the monopoly of manufacture for about a century and a half. The products of the Murano dealers were made from blown cylinders of glass which were slit, flattened on a stone, carefully polished and "silvered" by an amalgam. The manufacture of glass mirrors, with the aid of Italian workmen, was practiced in England early in the 17th century.

The term "silvering" as applied to the formation of a metallic coating on glass to give it the properties of a mirror was, until the middle of the 19th century, a misnomer. The old process consisted in applying a thin amalgam of tin and mercury to the glass surface. On a table was spread out a large sheet of thin tin foil. All creases were completely removed. A small quantity of mercury then was rubbed lightly over the whole surface. After brushing away the scum and excess metal, more mercury was poured upon the quickened foil until there was a sufficient amount to float the glass. The glass was slid over the surface of the mercury and held down with weights for about twenty-four hours. It was then removed to a drain where the drying and hardening process was started.

In 1835, Baron Liebig observed that on heating an aldehyde with an ammoniacal solution of silver nitrate in a glass vessel a brilliant deposit of metallic silver was formed on the glass surface. This process was placed on a commercial basis about 1840, and it is still used today with some modifications[8].

One of the quickest and most satisfactory methods of silvering glass in the laboratory is the Rochelle salt process here described. If the following directions[9] are carried out *in detail* a beautifully silvered glass will always result. There is no explosion hazard if the work is done as directed.

Experimental

Preparation of Solutions. Label two large wide-mouth bottles Solution No. 1 and Solution No. 2. Place in No. 1 (amber bottle) 23.2 grams of silver nitrate, and pour over it 16.1 ml. of concentrated ammonium hydroxide. Shake and let stand for three or four hours, or better, overnight. At the end of this time add 150 ml. of distilled water and filter. However, if it is desired to do the silvering at once, and your solutions are not made up, proceed as follows: Add 22 ml. of distilled water to 23.2 grams of silver nitrate and 16.1 ml. of ammonium hydroxide. This solution will turn black. Add the remainder of the 128 ml. of distilled water, and filter.

In bottle No. 2 place 23.2 grams of Rochelle salt and 162 ml. of distilled water. Stir until dissolved, shake well, let stand about one-half hour and filter.

Your solutions are now ready. They are sufficient to silver at least a dozen or two florence flasks of 200 ml. capacity. We advise the use of the solutions soon after they are made. Undesirable and even dangerous changes may occur in the silver solution on standing.

Cleaning of glass surface. Wash the glass with cleaning solution, tap water, distilled water, and, lastly, with a solution of stannous chloride. The chloride solution can be made up just before the silvering is done, by adding just enough of the stannous salt to give the water a milky look. If small flasks or beakers are to be silvered, the same cleansing process must be followed,

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1911358

The Fig . . .

• By Fred M. Schellhammer, Ph. D., *(Fordham University)*

DEPARTMENT OF BIOLOGY, EVANDER CHILDS HIGH SCHOOL, BRONX, NEW YORK.

Dr. Schellhammer here presents some of the less widely known facts about one of our common foods, one which, indeed, has the properties of a medicine.

He tells about the different varieties of fig, the development of the flower and the fleshy receptacle, pollination, and the difficulties of cultivation.

His account of the pollination of the caprifig, interesting in itself, affords an excellent example of a necessary plant-animal relationship.

Fig is the popular name given to plants of the genus Ficus of the mulberry family. That the fig was cultivated at a very early date seems evident from its mention in the Bible. Brought to Europe from Carica by the Athenians, it became a chief food of the Greeks. It has been studied ever since the time of Aristotle and Theophrastes, but an exact knowledge of its development, especially of the "fruit," is due primarily to the work of Sohm-Loubach in 1882, and Tschirch and Rorosini in 1911.

As a member of the Moraceae, the genus is related to the paper mulberry, the osage orange, and the bread fruit. The genus itself includes over 600 species, many of which are not without considerable interest. The famous banyan, noted for its epiphytic seed and aerial roots, is a member of the genus. The noted banyan in the Calcutta Royal Botanical Garden which germinated in a date palm, in 1700, and which, at present, is over 42 feet high with a crown of more than 850 feet, is probably universally known. The banyan and Ficus religiosa often germinate in the crevises of buildings which they finally destroy. The rubber plant, decorative pride of many an American home, is a member of the genus.

Ficus carica is one of the most widely cultivated of the genera because of its food value. It is a bush or small tree with broad deciduous leaves. The fruit is a solitary receptacle borne in the leaf axils. Male flowers, few in number, are borne in the upper portions of the receptacle cavity. It is the enlarged receptacle with its many single-seeded carpels which forms what is often erroneously called the fruit. Indigenous to Syria and Asia Minor, the plant is cultivated in most Mediterranean countries. Although not grown in the district commercially, it succeeds as far north as Pennsylvania and New York where it is not uncommon to see the bush covered for winter protection with burlap, straw, and even old boilers. However, even when a severe frost destroys the old cane, second growths occur.

It is in the flower and the development of the fleshy receptacle that the fig presents its most interesting aspects. The staminate flowers within the receptacle have 1-3 united stamens. The pistillate flowers have one-celled ovaries which ripen into achene fruits buried within the receptacle, which is known botanically as a syconium. The early wild type, the caprifig, is monoecious although many of the cultivated varieties are dioecious.

The pollination of the caprifig presents one of the most remarkable of interrelationships between animals and plants. This wild fig bears three generations of flowers and fruits in a year. The first crop, the profichi, are formed in February. The inflorescence bears numerous male flowers just inside the apical pore of the receptacle. Lower down are borne numerous female flowers with short styles and single rudimentary ovules. Female wasps (Blastophaga grossorum) deposit an egg in each of the ovules. The larvae hatch, feed, and undergo metamorphosis. The male wasps gnaw their way out, pierce the walls of the gall flowers containing female wasps, and fertilize the females. When the female wasps leave the pistillate flowers they are liberally sprinkled by the pollen of the now ripe male flowers. The wasps fly to new, younger inflorescences which contain only female flowers with long styles. Although the wasps are unsuccessful in their attempts to lay eggs, they do pollinate the stigmas. This second crop, the fichi, ripen in the fall and are fleshy and edible. Meanwhile a third generation of syconia, the mamme, develops, and the wasps lay their eggs in the gall flowers which alone are present. In these the larvae pass the winter, the cycle being repeated in the following spring.

The cultivated fig has long been subjected to a practice as ancient as the art of fig raising, namely caprification. This ancient practice consisted either of growing capri fig trees in the fig orchards, or actually cutting branches of the wild fig bearing profichi and laying them across the branches of cultivated varieties. Whether or not the reasons for this were understood may be gathered from a statement by Kerner and Oliver that

> "The process of transference called caprification is believed by growers to improve the fig. But this opinion is incorrect. The fig does not require the intervention of the wasp to become sweet and juicy. Ficus inflorescences entirely unvisited by wasps ripen into excellent figs although there is no fertile seed. It seems, therefore, that caprification is traditional and was important only when fertile seed as well as good fruit was required. Since cuttings are now used, caprification is superfluous."

Is caprification superfluous? Although the cultivated fig was introduced in California as early at 1710, difficulty attended the attempts to introduce fig cultivation

Continued on Page One Hundred and Nineteen

Nylon, New Synthetic Fiber

• **By Sister Mary Crescentia O'Connor, R.S.M., Ph. D.,** *(Catholic University)*

DEPARTMENT OF CHEMISTRY, COLLEGE MISERICORDIA, DALLAS, PA.

The women of America were intensely interested a few months ago when nylon hose were placed on sale for the first time. What did they look like? How would they wear? What about the price? Would they displace silk? These questions have already been answered.

But hosiery is only one outlet for one kind of nylon. There are many nylons possible, and many potential uses for them.

Sister Crescentia has brought together much interesting information about nylon. She states that her paper is based on a memorandum, "Some Facts About Nylon," supplied to her by the E. I. duPont De Nemours Company of Wilmington, Delaware. Permission to quote from the article and from various patents relating to nylon were granted by the duPont Company.

●

One of the first things that strikes the modern student of science is the enormous amount of activity that is to be found in many widely different fields. Every industry of importance has its staff of scientists. Most of them are engaged in researches that are designed directly to further the interests of their employers. Knowledge is not sought for its own sake, but for the commercial advantages it may bring. This is applied research. But there are many scientists, at the universities as well as in industry, who carry on researches with no thought that the results of their work will ever be of practical use. This is pure research.

Formerly, the United States lagged in pure research. The American scientist was noted throughout the world for his ability to see a possible practical application for a fundamental scientific discovery that someone else had made, and for his skill in building a pilot plant to prove that his idea would work. But he was not thought of as an innovator, an originator. He made few fundamental discoveries. Now all this is changed. During recent years the United States has made major contributions to chemical theories, products and processes. With war now disorganizing the laboratories of Europe, America has a splendid opportunity to intensify its efforts and keep the flame of pure science burning.

The results of the application of science to industry have been most gratifying. Among the recent striking achievements of industrial chemical research are the new synthetic fabrics. Sharing the spotlight with the other products that are replacing natural fibers is nylon, a twentieth century marvel made of such cheap and abundant materials as coal and air and water. This fabric is one of the top subjects of general interest today. Mention is made of it in scientific and trade journals, in business periodicals, in industrial magazines, in newspapers, and in digests and surveys of various kinds. Such attention is deserved, for the creation of this synthetic fiber, an American invention, will make it possible for American manufacturers to compete successfully with Japanese silkworms. It is an outstanding triumph of the value of scientific research in industry.

What is the history of this interesting material? How was it invented and developed?

The story of nylon dates back to a research program fostered by Dr. Charles M. A. Stine, vice president of the research division of the duPont Company, and recipient of the Perkin medal for distinguished service to chemistry in January of this year. In 1928, Dr. Stine persuaded his company to appropriate a considerable sum of money for pure research, research designed primarily to develop fundamental information with no thought that the knowledge gained would have practical value. Most of the research previously carried out by the duPonts had been directed toward immediately practical ends.

The first study undertaken under the new research program was concerned with the mechanism of polymerization. Chemists have long been interested in this subject but they know far too little about it. Through its study it was hoped to obtain new ideas as to the constitution of certain kinds of matter. But from this study of polymerization came not only new information of academic importance, which was promptly released to the world in scientific publications, but also other results of much practical value. Among these were the invention and development of nylon.

One of the chemists who worked on the project was Dr. Walter H. Carothers. Only a few days before his death, in 1937, he had applied for the basic patents that protect nylon and the ways of making it. After the study of polymerization had been carried on for about two years, a chemist who worked in Dr. Carothers' group noticed that the molten material with which he was working when pulled from the still could be drawn to a form resembling a fiber of silk. It was found also that, even after cooling, the filament could be drawn to several times its original length. This observation was extremely important, for such a phenomenon had not previously been noted.

Thus, as if by accident, nylon was discovered. But this was only the beginning. Many difficulties were encountered and had to be overcome in developing the basic idea. Hundreds of superpolymers had to be synthesized before the resulting material exhibited the characteristics that a good textile fiber must have. Presently, however, fibers which appeared to be definitely

promising were spun by hand from one of the superpolymers. There was much work still to be done. Diligent research continued, and on October 27, 1938, the duPont Company announced to the world the new nylon family of synthetic materials.

Nylon is officially and scientifically defined as "a man-made protein-like chemical product (polyamide) which may be made into fibers, bristles, sheets, and other forms which are characterized, when drawn, by extreme toughness, elasticity, and strength." Because there has been some misunderstanding about the term nylon, duPont officials recently explained that it is a generic term, not a registered name nor a trade mark. The word has no significance etymologically or otherwise. When the first polyamide was synthesized, it was thought advisable to select a simple name, one not likely to be mispronounced, by which this new group of synthetics might be designated. After considerable deliberation, the term nylon was finally selected. It does not refer simply to fibers or yarns spun from a synthetic polyamide but to the polyamide itself, from which fibers and other shapes may be formed.

Strangely enough, nylon is the first synthetic material, suitable for use as a textile fiber, that is derived from inorganic substances. All other synthetic fibers come from organic materials derived basically from either plants and animals. Nylon is a "protein-like material"; hence it contains the same chemical elements as silk. Yet nylon has no exact chemical counterpart in nature, and fibers made from it cannot, therefore, be properly referred to as "synthetic silk." Furthermore, since nylon is not a product from cellulose nor has it a cellulose base, it cannot properly be considered a type of rayon. In fact, it is importantly different from rayon, since the latter contains no nitrogen. The nylon family of materials is not only new but also quite different from any other existing textile product.

How is the synthesis of nylon accomplished? The fiber-forming polyamide can be prepared by the reaction of diamines with dicarboxylic acids or amide-forming derivatives of dibasic carboxylic acids. The diamines most suitable are those having at least one hydrogen attached to the nitrogen atom; hence, the di-primary amines, primary-secondary amines, or di-secondary amines, but never diamines in which either group is tertiary, are used.

Fiber-forming polyamides may be made from (1), one or more diamines with mixtures of amide-forming derivatives of different dicarboxylic acids; (2), reaction of one or more amines with mixtures of amide-forming derivatives of different dibasic carboxylic acids; (3), reaction of one or more amines with mixtures of dicarboxylic acids and amide-forming derivatives of dibasic carboxylic acids, with one or more monoaminomonocarboxylic acid or amide-forming derivative of such an acid.

It is apparent that many different types of nylon material are possible. Actually, by interpolymerization of various dibasic acids, amino acids, and diamines, thousands of different nylons may be synthesized. For example, one dibasic acid could be made to react with two different diamines at the same time and in varying proportions, or vice versa. Also, two or more different nylon polymers might be blended to give a composition entirely different from the original nylons. Such an almost unlimited number of nylons will provide materials with as many different chemical and physical properties. One type might be flexible, while another might be stiff and rigid. Translated into human needs this means an almost endless list of possible uses for nylon.

From what material may this family of nylons be made? What natural raw materials may be used in its production?

Since nylon is a family of related polyamides and not one particular substance, if follows that various raw materials may be utilized in making the various types. For example, sebacic acid, a dibasic acid derived from castor oil, has been used for making one type of nylon found useful for certain purposes.

Another special type of nylon which appears promising for the manufacture of textile yarns can be made from a dibasic acid and a diamine each of which has been derived from phenol. Phenol, in turn, it will be recalled, is commonly obtained by the destructive distillation of coal. In the formation of the dibasic acid from phenol, oxygen is needed. Ammonia, which may be made synthetically by causing the hydrogen liberated from water to combine with nitrogen, is necessary for the making of the diamine. The oxygen and nitrogen required for these reactions may be obtained conveniently from air. Thus, it is evident that this particular nylon is obtained ultimately from three of nature's raw materials, coal, air, and water. Both economically and industrially significant is the fact that in the manufacture of nylon many intricate chemical reactions must be carried out involving elaborate and costly equipment, with rigid control at every step of the process. This will help to explain why a material made from such abundant natural substances cannot be produced in fabric or fiber form to sell at relatively low prices.

What are the properties of nylon which make it utilizable and desirable? When any primary or secondary diamine unites with any dicarboxylic acid or amide-forming derivative of a dibasic carboxylic acid, the resulting nylon shows crystalline properties. Like all crystalline substances, each different kind of nylon has a characteristic and rather sharp melting point. Some have a low melting point while others show a melting point as high as 600°F. This resistance to heat, then, is determined by the chemical structure of the particular nylon and is one of the important factors which helps to determine the use to which the material may be put.

Again, nylon for use in textiles shows considerable resistance to water and the commonly used dry-cleaning fluids. Absorbing much less moisture than do the other textile fibers, nylons are found to be substantially as strong when wet as when dry, and the filaments after repeated washings are practically as well formed as when taken from the original package.

Furthermore, its producers claim that nylon fabrics are as resistant to indoor and outdoor light as are the corresponding silk fabrics. They undergo no appreciable

deterioration in the absence of light, hence may be stored for long periods of time without injury. It is likewise asserted that nylon fabrics are absolutely proof against moths, and such fungi as are responsible for mildew.

Its very good insulating properties, together with its high resistance to abrasion, makes nylon suitable for electric purposes. Massive pieces of nylon appear opaque, sheets of nylon are somewhat translucent, while films made from the nylon material, by special processing, may be transparent. Oriented nylon is highly doubly refractive, and when it is examined by means of nicol prisms all colors of the spectrum are visible. Toughness, another characteristic, makes nylon capable of resisting severe use and of lending itself well for use in fishing lines and in various types of brushes.

The most interesting physical property of nylon, perhaps, is its ability to undergo a very high degree of permanent orientation when subjected to stress. If a fiber of nylon which has been made under low tension is subjected to further tension, it can be drawn from about four to seven times its original length. The highly interesting, yet puzzling phenomenon of orientation, occurs during the stretching process. The long, chain-like molecules of the undrawn nylon fiber, when sectioned longitudinally, show a random arrangement of the molecules, while the same type of sectioning of a nylon fiber after orientation shows an orderly arrangement of the molecules. They become parallel to one another and thereby create a powerful inter-molecular attraction. It is this force that is increased in nylon during the stretching process. This factor, together with the extreme length of the molecular chains in the nylon filament, gives to the superpolymers their great tensile strength. The oriented nylon fibers, for a given size, show properties that are stronger than corresponding fibers of cotton, wool, linen, silk, or rayon. During the orienting process, particularly as applied to textile fibers, the nylon material acquires a high degree of true elasticity and great tensile strength. It might be well to recall that elasticity and stretchability are not synonymous terms. The measure of true elasticity is the degree to which the stretched material will return to its original length. Curiously enough, this elongation of the nylon fiber brings the material to the state in which it is truly elastic; that is, a state in which it can be stretched a little further yet will return to approximately the same length it had before being stretched the second time. This stretching and elasticity may be illustrated by assuming an undrawn nylon fiber, say, ten inches long, of such a type that it must be stretched to a length of forty inches before it shows the property of elasticity. After this ten-inch fiber is stretched to forty inches, it will remain forty inches indefinitely; but if it is then stretched to, say, forty-four inches and released, it immediately contracts to approximately its forty-inch length. Strangely, too, this high degree of elasticity is not lost by the filament, even if kept stretched for days.

How is nylon to be used? What are some of its most promising outlets? The first big field for the utilization of nylon fibers is in the manufacture of fine hosiery. Silk stockings are being challenged for the first time in history. Until the development of nylon yarn, silk was the only textile fiber which possessed the combined strength and elasticity demanded of a yarn for use in fine hosiery; but from nylon it is possible to spin yarn having a strength-elasticity factor superior even to that of silk. The laboratory and experimental stages are over; hosiery mills are in production and department stores are now selling nylon hosiery. The stockings look as sheer as silk hose of equal weight. They are said to wear even better. Their cost is not excessive. Later, they will be cheaper.

Hosiery is merely one of the major outlets. Nylon makes stronger and lighter parachutes, both the fabric and the shroud. Nylon fibers can be made into lace, women's dress goods and underwear, upholstery materials, and lining for men's suits, and rugs and carpets. Nylon sewing thread is being offered under the trade name "Neophil."

But all nylons are not textiles. Nylon in the form of non-filament has met with pronounced success when made into bristles for use in tooth brushes and other toilet brushes and in special types of industrial brushes. Dr. West's "Miracle-Tuft" tooth brush, made from "Exton," the trade name of synthetic bristles derived from nylon, has been on the market for over a year. Fish-line leaders, surgical sutures for operations, and strings for tennis rackets are only a few of the uses to which this polyamide may be put.

This new chemical wonder can be used to coat paper, leather, cloth, and wire mesh, to produce oilproof paper containers, a superior patent leather, long wearing, flexible, water-proof clothing, and a sturdy kind of transparent window glass.

When applied to fabrics, the new coating produces superior shower curtains, window shades, washable table cloths and rain coats. Nylon spread over wire mesh, hardens into a strong glass that transmits the healthful ultra-violet rays which ordinary glass cuts off. Nylon forms an enamel so tough that copper wire coated with it will break before the coating cracks.

Nylon is a significant scientific and industrial achievement. It is proof that pure research, that seemingly has no practical value, may result eventually in the discovery and development of new products that will enrich men's lives and help further civilization. ●

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Photographing American Wildlife

● **By Robert B. Ford**

WILDLIFE PHOTOGRAPHER, HOMESTEAD, PENNSYLVANIA.

Here is a story about a most unusual occupation,—hunting with a camera instead of a gun.

Mr. Ford, who is a great lover of animals, has shown his pictures before many schools, including numerous Catholic school groups. The Most Reverend Hugh C. Boyle, Bishop of Pittsburgh, has expressed to Mr. Ford his interest in and his approbation of this out-of-the-ordinary educational project.

Modern children have few contacts with wildlife. They should have more, even if pictures must substitute for reality. To attend a "Ford" showing is an event in the life of any child.

●

A hobby sometimes becomes a lifework.
To my surprise one of my hobbies did.

I first began to photograph wildlife for my own amusement. I had no thought then that my pastime would become a vocation. But as I gained experience, the work became so fascinating, so thrilling, and in my opinion so worthwhile from an educational point of view that I found it desirable, eventually, to devote my entire time to it. Now all I do is take motion and still pictures of wild animals in their natural environments and show them before schools, clubs, and other groups.

In hunting with a camera I have traveled a distance greater than twice around the earth. I have visited more than forty states and provinces in the United States, Canada, and Mexico, trailing, studying and filming hundreds of birds, wild animals and reptiles. I have exhibited the results of my skill before thousands of interested persons. In taking and showing these pictures I feel that I am rendering an important service in the cause of education.

A mountain lion at bay in the Grand Canyon. This is a daylight picture taken with the camera held over Mr. Ford's head.

Most young people today, especially those who are city bred, know little of the appearance, habits and peculiarities of our native birds and animals. They have never experienced the thrill of watching wild animals in their natural habitats. They have had no opportunity to learn at first hand what goes on in the forest, the desert, the mountains. But I know they are interested in such things. Given the opportunity, they would be just as much interested as were the youth of older generations who learned their animal lore by actual contact, and who quite likely picked up other bits of more or less authentic information by listening to the tales of their elders—hunters, trappers and travelers.

For many students, field trips are out of the question. Pictures must serve. Pictures do not lie. One picture is better than many words. As an aid to learning, motion pictures are more valuable than still pictures, for action pictures of animals leading their normal wild lives make far more vivid impressions on those who see them than do the most highly detailed descriptions in the books.

Showing such pictures is an interesting experience. Each new audience provides a new thrill. But taking the pictures of animals is fun, too, far more fun than hunting them with a gun. It is more difficult, also. Excitement, danger, hardships, success, failure, all come to the hunter with the camera. The photographer needs a sense of values, a quick mind and good nerves. Pictures will not wait. Speed is essential. The growl of the bear may come from only a few feet away. The grip of an eagle's claw, the strike of the rattler, the bullet-like sting of a poisonous insect, all are hazards the photographer must accept.

The hunter has only to see his quarry and to shoot. The photographer must do more. After seemingly endless tramping he finds a worthy scene. He must pause to observe. He needs to estimate the distance closely, judge the light value of the animal or bird, and sight the lens of his camera before he takes the picture. If any detail is overlooked, the picture will be a failure. Occasionally, but not often, the photographer will chance a quick shot, but success seldom attends such a procedure.

Sometimes I make the animal take its own picture. After placing my cameras in position I arrange an automatic trap to be sprung when the deer or wildcat or other animal I am studying strikes the string that I have stretched across its path. I have obtained some excellent pictures by this method.

Some of my most satisfactory work is done at night. Even when I work by day artificial light is sometimes necessary. I carry rather elaborate equipment. I use a portable gasoline engine to run an electric light plant

An ocelot tiger cat takes its own picture in a jungle on the west coast of Mexico.

with powerful lights and reflectors. I need hundreds of feet of wire. There are distance gauges, light meters, light temperature meters, heaters, a portable blind, tree climbers, an adjustable aquarium, and many other necessary articles, as well as plentiful supplies of film for my five still cameras and my motion picture camera as well.

With such a load of equipment I may drive all night in freezing weather back into the mountains to take pictures of a bear in her den surrounded by her young cubs. Then, perhaps, when everything is finally arranged and a good picture is in prospect, I leave very suddenly. To have an infuriated mother bear charging at one is not a pleasant experience. It is always well to save one's own hide. Later I will try again, or, perhaps, I may decide to use the telephoto lens from a distance and photograph the mother and cubs in action.

As I drive along an unfrequented road in the darkness with the cameras mounted on my car ready for instant action, my headlights pick out in the roadside shrubbery a pair of sparkling eyes. Is it a bear, or deer, or wildcat, or fox or coon? Blood tingles; but a nearer approach disappoints. It is a common house cat, or perhaps a wild one, out for its nightly kill of game. On we go over the mountain and down the other side. Another pair of eyes, this time on the road, and apparently content to permit the car to approach closely. Only a rabbit!

Our headlights light up the trees ahead of us. We round curve after curve. More miles, and more eyes that look like balls of fire. It's a deer! We see it plainly. For a moment it stands immobile, then it dashes across the road, up the hill and out of sight. There is another! Steady! Our fingers seek a switch. Ready, get set! Bang! Fireworks! What a leap! We press another button. Another gunlike report as the flash powder from a second container illuminates the mountainside. Another picture, and another! At last we have enough. In this section of the country it is not difficult to find deer. One night on a trip of some seven hours, we encountered 278 deer.

Now we stop at a spot near which I have two trap cameras planted on a pole set out above the water of a pond just off the shore where deer come to drink. I have arranged it so that the deer will strike a string strung across the path and thus set off the flash. At this time of night it takes more than a little courage to go through the head-high dew-covered thickly matted swampgrass, a snake hangout where we hope "none are poisonous." We think of the snakes as with flashlight in hand we slide down the steep bank off the edge of the road and make our way to the cameras. Our approach is heard. Twigs break, water splashes and deer scamper away. We fear that our work has been in vain, but surprisingly we find our string trap has been tripped and that both cameras have taken pictures simultaneously. (A picture taken by this method is shown in Mr. Ford's advertisement on another page in this number. Editor.)

There is no dearth of wildlife subjects for the camera. I have taken pictures of hundreds of animals all over the country. In Pennsylvania alone, 25,000 miles of travel have yielded not only innumerable still shots but splendid motion pictures in color of deer, bear, coons, porcupines, rabbits, eagles, owls, hawks, songbirds, turtles, frogs, insects and many others. Our film on snakes shows how to distinguish between the poisonous and non-poisonous varieties. It demonstrates that Pennsylvania snakes, at least, do not eat eggs or young birds in their nests. We have been able to photograph a screech owl preying on young pheasants, and, in slow motion, water fowl in flight. We can show that songbirds return to the same locality year after year. Our deer films are especially fine.

Good color photographs are not easy to take, especially in the northern states. During not more than a quarter of our daylight hours can good color work be done. Most of my 1940 animal and bird scenes were taken in the daytime, but I need artificial light to increase the amount of ultraviolet rays.

I like to take animal pictures. I like to show them to the young people today who now are or who may later become interested in the lives of our native wild animals. ●

Marvels of Adaptations

Nowhere, as in the Southwest, is the capacity for adaptation—by plants and animals, including human beings,—so dramatically illustrated.

Nearly all of the areas included in the group of prehistoric ruins, and scientific areas administered by the National Park Service of the Department of the Interior, exemplify this adaptation. Only those plants and animals that were able to adapt themselves to desert heat and glare by day and extreme drops in the temperature at night, to scarcity of moisture and little shelter, have survived. These survivals are thrilling, even to the layman, in their exhibition of hardihood and ingenuity.

Not less fascinating are the remains of the ancient canals by which the prehistoric Indians irrigated the land and cultivated their crops of beans, corn, squash and melons. Even the caliche walls of their ruined dwellings are adaptations to environment.

Science Equipment in Elementary Schools

● **By Tunis Baker. M. A.** *(Columbia University)*

DEPARTMENT OF SCIENCE EDUCATION, STATE TEACHERS COLLEGE, PATERSON, N. J.

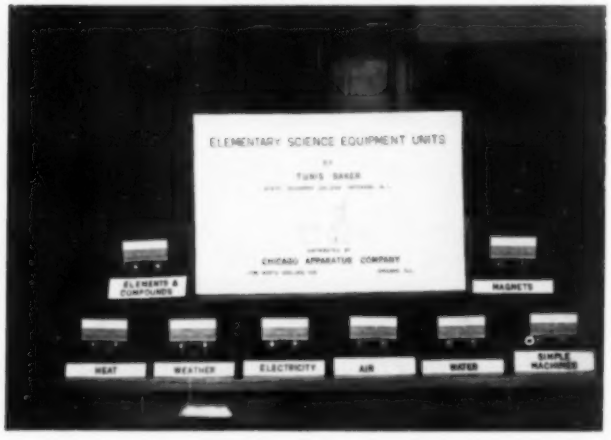
This is an interesting account of a new and convenient aid to science teaching in the grades.

These teaching Units first came to the Editor's attention through the advertisement of the Chicago Apparatus Company in our September issue. The plan seemed so sensible and practical that he prevailed upon Mr. Baker to describe the sets for our readers and to tell how they may be employed.

Incidentally, the writer presents the other side of the home-made apparatus problem, and does it rather convincingly so far as the grades are concerned.

●

Proper equipment and apparatus for teaching science in the elementary schools have as yet been given too little attention. Nevertheless, the lack of simple, economical apparatus to supplement the many excellent textbooks now available, presents a major difficulty in teaching science in the grades. If science in the elementary schools is to be deepened and enriched with a real activity program, then more and better equipment than is now in use must be provided.



Elementary science equipment units.

In recent years considerable emphasis has been placed upon the employment of homemade apparatus and second-hand equipment. Science periodicals and books are filled with suggestions describing ways and means of utilizing such material. For many years this writer, conforming to this general trend, has advocated both to prospective teachers and to teachers in service the use of homemade apparatus. But in spite of all the stress placed upon the importance of pupil-and-teacher-constructed equipment, he finds few teachers who actually are following this procedure. The reason for this condition is obvious.

In schools where the curriculum has been departmentalized, science is usually taught by a specialist who can give full time to the organizing, collecting and making of materials of instruction. In most elementary schools, however, science is added to the teaching load of the regular classroom teacher, who is already burdened with a more or less heavy program. For these teachers, the majority of whom have had little or no training in science education, the task of assembling and constructing their own material is disheartening. Occasionally a teacher with unusual ability and energy will spend considerable time gathering and improvising her own equipment, but the average classroom teacher is not inclined to use her spare time rummaging through garages, junk yards, five and ten cent stores or similar places usually recommended as sources of supply.

It was with this condition in mind that the author in collaboration with the Chicago Apparatus Company of Chicago, Illinois, developed a series of science units designed to aid the elementary school teacher in solving the vexing problem of providing adequate material with which to carry on a suitable science program.

Our "Science Units for Elementary Schools" are unique in that they not only furnish the teacher with many science activities and experiments, but also supply her with all equipment and apparatus necessary for conducting such activities. The following eight complete units make up the series—

UNIT 1. Experiments with Air.
UNIT 2. Experiments with Magnets.
UNIT 3. Experiments with Water.
UNIT 4. The Weather.

Pupil demonstration of the inclined plane.

UNIT 5. Experiments with Heat.
UNIT 6. Experiments with Electricity.
UNIT 7. Experiments with Simple Machines.
UNIT 8. Experiments with Elements and Compounds.

To allow for differences in curriculums, the selection of experiments to be performed in any one class is left entirely to the individual teacher. The units can be used in all grades from one to nine inclusive. Although they are primarily intended for use in elementary schools, the entire series can be readily adapted to smaller high schools where adequate funds are not available for separate laboratories.

Each unit includes a booklet of instructions containing some ten or fifteen experiments. The experiments which are illustrated with simple line drawings, include directions easily followed by the instructor. A brief explanation at the end of each experiment interprets for the teacher the scientific principles involved. For further information she may refer to a comprehensive bibliography of elementary and general science books listed with every unit.

The outstanding feature of these Science Units, however, is the box of equipment accompanying each booklet. Constructed of neat, durable, cloth-covered fibre, with drop handles, the boxes contain everything from a spool of thread to a standard piece of apparatus. The amount of material supplied with each box is kept at a minimum and the cost is consequently nominal. There is very little duplication of material and the few articles found in more than one box, such as beakers and test-tubes, are standard equipment used in every laboratory. Requiring little space, the units can be stored in a cupboard or closet where any teacher in the building may secure them as the need arises. In small districts of two or three schools, the boxes can be transported easily from one building to another.

The accurate construction of all apparatus insures dependable results. Equipment that can be relied upon to demonstrate the laws of science inspires pupils with respect for scientific accuracy.

The criticism might be made that science units of this type, set up in separate containers, smack too much of the cook-book method of instruction, whereby the teacher merely follows a set of prescribed directions just as a cook follows a recipe. The uses to which the Science Units can be put, however, will vary with the ability, the imagination, and the ingenuity of the teacher. What the author hopes is that they will inspire some degree of confidence in those teachers who, heretofore, have been timid about teaching science because of a lack of proper material. The units are not intended as a course of study to be rigidly followed from day to day by the classroom teacher. They are simply a means of placing at her disposal some simple, ready-made equipment that can be used as the occasion demands. The experiments described in the booklets are merely suggestive of the many kinds of activities that can be carried out with the material provided.

These Science Units are as suitable for the progressive school that employs the project method of integrating one or more subject matter fields in a problem as they are for the school that divides the week's program into definite subject matter periods. They may be used to motivate a lesson or a whole unit of work. A few well chosen demonstrations may stimulate in pupils a desire for further experimentation and encourage them to explore other fields of activity. An experiment illustrating air pressure, for instance, may lead to a project on the weather. On the other hand, they are ready for instant use when, in the course of a class discussion, a question arises that needs but a simple demonstration for clarification. A story of a submarine disaster in the day's news may bring up a discussion of the principle of buoyancy that can be made clear in a few minutes without the necessity of collecting or constructing a lot of equipment before the demonstration can take place. To spend several hours, or days even, building equipment out of old tin cans and bottles in order to present a ten or fifteen minute lesson may defeat the purpose of the experiment.

Some demonstrations may be given by the teacher, and others, not requiring the use of too delicate or expensive material, can be explained by pupils. Teacher-demonstration lessons have the advantage of being more accurate and economical of both time and money. Pupil-demonstrations, on the other hand, develop many skills and habits in the manipulation of equipment and apparatus valuable to any pupil in the study of science. Of course, all pupil-demonstrations should be carefully supervised at all times.

It is true that pupils gain much that is desirable in the process of constructing their own apparatus, but as pointed out in the *Thirty-first Year Book* of the National Society for the Study of Education: "A piece of equipment or apparatus is to be evaluated in terms of the educative experience which makes it possible. It is necessary to stress experience as a criteria for evaluating equipment. This experience may indicate the need for expending funds in certain directions, or it may in other cases indicate the unwisdom of devising new and sometimes more elaborate ways of performing exercises that will require only homemade material. Too often teachers of ability and experience devote a major portion of their energies to the creation of laboratory and demonstration apparatus that has the sole merit of utilizing cheap materials. The plaudits which this activity attracts are often disproportionate when viewed in terms of the educative experience which the new apparatus provides. A purchased piece of apparatus is justified if its contributions in terms of pupil experience is great, and if it releases the teacher's energies in the right directions."

This writer believes that Science Units for Elementary Schools will supply a long felt need. They should not only open up new fields of experiences to pupils eager for science knowledge, but also to teachers, handicapped by an inadequate science background, they should provide real and practical help and release energies for more effective teaching. ●

A CALENDAR

OF MONTHLY PROJECTS SUGGESTED FOR THE CONTINUAL STUDY OF LIVING THINGS

By Sister M. deLourdes, S. S. J., A. B. *(Duquesne University)*
ST. JOSEPH HIGH SCHOOL, NATRONA, PA.

Sister de Lourdes compiled this Calendar for presentation at the 1940 Duquesne University Science Conference in connection with her discussion of the part laboratory work may play in making high school science more productive.

It is offered here to suggest to teachers of biology and general science certain worthwhile activities that may be undertaken at different times during the year.

●

SEPTEMBER

Apples

Varieties: Winesap, Wealthy, Jonathan, Baldwin, Northern Spy, Maiden Blush, Russet, McIntosh, Ben Davis, Haralson, Grimes Golden, Tolman Sweet, Secor, Sharon.

Peaches

Varieties: Hale, Polly, Elberta, Chinese Cling, Sungold, Anoka, Golden Jubilee, Mayflower, Champion.

Pears

Varieties: Bartlett, Seckel, Keifer, Patten, Lincoln, Duchess, Douglas.

Plums

Varieties: Blue Damson, Green Gage, Superior, Toka, Kahinta, Waneta, La Crescent.

Study Suggestions: Note the difference in shape, color, size, and seeds of each species. Note the color of seeds, the arrangement of seeds, the number of seeds. Cut a cross section and from it sketch the seed arrangement. Cut longitudinal sections and note the seed arrangement.

Obtain some leaves from the various kinds of fruit trees. Examine the shape of the leaves; compare the shades of green in each variety; sketch the venation; note the arrangement on the stems.

Where does each species and each variety grow? When do the trees blossom? When does the fruit ripen?

Endeavor to find out their food value: Which fruits contain the various vitamins? Do fruits contain minerals? What sugars are present? Which acids are peculiar to the various fruits?

Nuts

Varieties: Hazelnut, Hickory nut, Black Walnut, English Walnut, Chestnut, Peanut, Pecan, Butternut, Pistachio nut.

Study Suggestions: Which grow on trees? Which grow on bushes? Which grow underground? Note the shape, the shell, the hull, the kernel of each. Examine any parasites found in the nuts. Food value and other study suggestions as listed above in regard to fruits.

Wheat Rusts and Corn Smuts may be obtained about this time.

Other topics for study as suggested above: Corn, Wheat, Grasses, Weeds, Flowers, Vegetables.

OCTOBER

Flowers

Varieties: Goldenrod, Asters, Coxcomb, Cosmos, Chrysanthemums, Dahlias.

Study Suggestions: Observe the colors; count the petals, the sepals. Compare the shape and arrangement of the petals. Note the stamens, the stigma, the pollen. Obtain a root of each; study the shapes and note the different kinds. Examine the leaves as to shape, color, arrangement on stem. Compare the seeds. Press and later mount flowers, leaves.

Insects

Beetles, Moths, Flies, Drosophila, Grasshoppers are obtainable. Fully grown caterpillars placed in jars will enclose themselves in cocoons where the process can be observed.

Leaves

Varieties: Oak, Maple, Sumac, Poplar, Sycamore, Willow, Walnut, Catalpa, Sassafras, Birch, Buckeye, Apple, Pear, Cherry.

Study Suggestions: Make a collection of various leaves; press and mount them for study of shape, size, color, and venation. Learn to recognize the trees by their shape, leaves, spread, height, and various kinds of bark.

Seed Pods

Varieties: Canna, Hollyhock, Four O'Clock, Cosmos, Morning Glory, Wild Cucumber, Thistle, Milkweed.

Balanced Aquarium

Materials: Valisneria, Sagittaria, Cabomba, Elodea, Ludwigia, Myriophyllum, Water Poppy, Lemna.
12 Snails, 2 Aquatic Newts, 1 Clam, 2 small Crayfish,

or

3 Gold Fish, 3 Glass Shrimp, 2 Japanese Snails,

or

4 Guppies, 10 Snails, 2 Clams.

Algae

Varieties: Oscillatoria, Nostoc, Oedogonium. These can be purchased in pure cultures. They can be kept indefinitely for study purposes. They can be used in small balanced aquaria with such protozoa as paramediam, stentor, vorticella, rotifers, etc.

NOVEMBER

HUNTING SEASON

Game

Varieties: Rabbits, Squirrel, Pheasant, Quail, Deer.

Study Suggestions: Where are they found? How are they hunted? Where do they live in winter? How? Obtain feathers of quail and pheasant for study. Of what use are skins of rabbits and squirrels? Pelts of deer and other large game? Study food value; economic value. Why is November the hunting season?

Birds

Varieties: Snowbunting, Tree Sparrows, Bobwhites, Grouse, Pheasant, Starlings, Meadowlark, Siskin, Juncos, Cardinals.

Study Suggestions: By providing shelters and means of feeding, students may attract winter birds to the vicinity of home or school. Watch for their coming now and in December. Learn to recognize them.

Fungi

Varieties: Bread Mold, Water Mold, White Rust of Crucifers, Yeast, Blue Molds, Mildew, Cup Fungus, Wood Fungi.

Study Suggestions: Place bread in a moist container covered with a bell jar. Observe cobwebby white filaments; note the filaments with black ends; watch for blue mold that usually follows bread mold; learn to recognize spores, mycellium. Culture other molds on lemon peel, meat, cooked potato, banana. Compare the differences.

Lichens

Varieties: Parmelia, Usnea, Cladonia Cristatella, Physcia, Cladonia Rangiferina.

Study Suggestions: Lichens may be found as crusts on stones or on the barks of trees. It may be found on the ground with mosses. It may be erect and branching. Look for these on decaying stumps, on dead branches of trees, sometimes on living branches. Watch the development of Parmelia, Usnea, and Cladonia Cristatella in a terrarium.

Balanced Terraria

Materials: Liverworts, Mosses, Lichens, Fern, 2 Newts or Salamanders, 1 Toad or Tree Frog, Land Snails,

or

Several species of Cacti, 1 Horned Toad, 1 Fence Lizard.

DECEMBER

Collections

Materials: Birds' Nests, Cocoons, Chrysalises, Galls, Tent-caterpillar eggs, Fungi, Winter Twigs.

Study Suggestions: Note the differences in birds' nests. Which are built in low bushes? Which along the branches of trees? Which at the junction of limbs? Which are held together with mud? What differences do you note in shape? Compare a cocoon and a chrysalis. What is the shape and general appearance of the cecropia moth cocoon? The Prometheus? The Luna? The Polyphemus? Collect and destroy tent-caterpillar eggs. Look for fungi on old tree stumps, or in decaying wood.

Bacteria

Materials: Potato broth; meat broth; hay infusion; water in which cut flowers have been standing; decaying matter; soil; dust; vinegar; yeast; sauerkraut juice; wheat, barley and rice in water. Make culture media of boiled potato: on one, place a drop of milk; draw a finger nail across another; expose another to dust in the air; place some fruit on the fourth.

Study Suggestions: How do bacteria obtain food? How do they reproduce? How do they destroy food? How do they flavor cheese? How do some cause disease? Name diseases that are bacterial. Study helpful bacteria; harmful bacteria; antitoxin; prevention of bacteria—refrigeration, drying, sterilizing, canning. Compare the color and forms of growth. Obtain pictures of the sphere-shaped or cocci; the rod-shaped, or bacilli; the spiral shaped, or spirrila.

PREVIOUSLY PREPARED STUDY OF LIVING THINGS:

Drosophila

Study Suggestions: Early in the fall culture of this fruit fly can be started in the laboratory. By December they will furnish material for study. The drosophila have been placed in a jar or milk bottle containing some crushed banana, a bit of yeast, and some filter paper to absorb the moisture. Watch the development through the larval and pupal stages.

Roaches

Study Suggestions: The pantry roach is easily obtained and can also be observed through its developmental stages in the laboratory. Watch them eat and drink.

Grasshoppers

A grasshopper cage started in earlier months should now furnish material for study of life.

Spiders

Spider cocoons furnish interesting study in a vivarium case.

Continued on Page One Hundred and Twelve

NEW BOOKS

Photograph by Robert Turriff Hance

The Microscopic World

By FRANK THONE, Science Service, Washington, D. C. Julian Messner, Inc., N. Y., 1940. 245 pp. Illustrated. $3.00

Mix a biologist, a bit of poet, an imagination that dips deep beneath the surface of the individual, that eases behind the scenes of the drama of life, with a pen that can do the mixture justice, and you have "The Microscopic World." Dr. Frank Thone, research botanist, staff interpreter of scientific discoveries for Science Service, has told in a picturesque but strongly factual way of the living world man did not discover until he had invented his greatest tool—the microscope. To read the Table of Contents is to want to read the book—"Seeing the Unseen, Invisible Lives, What are Microbes, They're Just Everywhere, They do the Strangest Things, They all had Parents, Many had two Parents, Sizes and Shapes, Bread and Beer, New Frontiers" and so on, to a better understanding of the microscopic world and to the entire world of living creatures.

R.T.H.

Introduction to Vertebrate Zoology

By WILLIAM HENRY ATWOOD, Milwaukee State Teachers College. C. V. Mosby Co., St. Louis. 1940. 511 pp. Illustrated. $3.75

This book deals briefly but well with the comparative anatomy of the Chordates. To the anatomy is added a suggestion of function and a worthwhile bit on interesting general information concerning each group. The evolutionary relationships are well handled. This book will probably be considered better fitted to the needs of the general student taking a cultural course in the subject than for those preparing for medicine. However, the breadth of its coverage makes it a book to be considered wherever comparative anatomy is taught, particularly if it is supported by a thorough laboratory guide to dissection. R.T.H.

American Mammals

By W. J. HAMILTON, JR., Cornell University. McGraw-Hill Book Company, Inc., New York, 1939. 434 pp. Illustrated. $3.75

The author has made a very successful attempt to gather together information on American mammals that has, heretofore, been but poorly available. With the purpose of calling attention to the importance of these forms in the balance of nature, he has discussed their habits under various broad headings such as: ancestry, adaptations, food, hibernation, migration, population, useful and injurious mammals. This book contains the sort of specific information concerning the habits of this group of animals that teachers need and can seldom find. Furthermore, it may serve well as a review of mammalian problems that will form the basis of future research. R.T.H.

Biology in the Making

By EMILY EVELETH SNYDER, Junior-Senior High School, Little Falls, New York. McGraw-Hill Book Co., Inc., New York, 1940. 539 pp. Illustrated. $2.80

The story of biological discoveries as the product of "real men," and the effect of these men and their findings on succeeding years of human history is amazingly well told in this book. Into it is packed an almost unbelievable amount of biological lore as well as the little intimate details of personal habits that make the men, from Aristotle to the present living workers, of this history real. Few reviews of biological history can compare with this and, in this opinion I think, high school and graduate students will alike concur. R.T.H.

The Cyclotron

By W. B. MANN, University of London. Chemical Publishing Co., New York. 1940. 90 pp., 31 figures. $1.50

In this small monograph the author has described the cyclotron as constructed by its inventor, E. O. Lawrence, and coworkers at the University of California. The basic physical principles are stated and explained, the operation of the instrument described, and its applications reviewed both in a brief general way and by description of typical examples of induced transformations. There is a useful list of 51 references.

For the average scientist who wants to know much more about the cyclotron than can be compressed into the usual dozen lines in a textbook on general physics, this little volume gives the answers. The author, Lecturer in Physics at the University of London, writes with admirable clarity. Unlike some English authors, he presumes not too much on the knowledge of the average physicist and chemist who may read his book. These attributes, combined with the tremendous scientific importance of the cyclotron as an instrument for basic research, give us a little volume of exceptional merit.

G.E.D.

Biological Drawings

By MAUD JEPSON, Greek Street High School for Girls, Stockfoot, England. Chemical Publishing Co., Inc., New York, 1939. 60 pp. Illustrated. $2.00

Fifty-seven large pages of semi-diagrammatic and well described drawings of the important parts of plants and animals make a unique book. A valuable reference book for all teachers of biology for in it they will find clearly illustrated the many structures of which they have never found a good "picture." The reviewer is not certain as to the value of such a book in the hands of students for whom it is intended. At least it is refreshingly different. R.T.H.

Directed Activities in Physics

By WM. O. BROOKS, Technical High School, Springfield, Mass. Oxford Book Co., New York. 1939. 272 pp. $0.69

This is a "workbook" and laboratory manual for secondary schools, designed for use with any physics textbook. The subjects covered are divided into 15 "units," each introduced by sections entitled, "Textbook References," "Outlines for Textbook Study," "Preview," "Glossary," and "Survey Questions." There is also a section of "summary tests" at the back of the book and an appendix of tables, etc. The experiments are generally well written and in practically every case are illustrated by one or more figures, rather exceptionally well drawn. There are some unnecessary inaccuracies and ambiguities in the definitions given in the glossaries. However, the book is generally attractive, logically written and, it seems, well adapted to the needs of the average secondary school. G.E.D.

Laboratory Manual of General Biology

I. Botany
II. Invertebrate Zoology
III. Vertebrate Zoology

By JOHN G. ARNOLD, Loyola University of the South, and Timothy L. Duggan. 4th Edition. C. V. Mosby Co., St. Louis, 1940. 275 pp. Punched to fit standard binders.

This loose-leaf manual is as much an abreviated textbook as it is a laboratory guide. The directions for dissection are long and not easy to follow. Illustrations would in no way hamper the aim of this book. They would also serve to make it more understandable, and would permit material reduction in the amount of text. R.T.H.

An Introduction to Biochemistry

By WM. R. FEARON, Trinity College, Dublin. C. V. Mosby Co. St. Louis. Second Edition. 1940. xii + 475 pp. $3.75.

That English, American, and Spanish editions of this book have appeared since its first publication in 1934 indicates something of its importance and value.

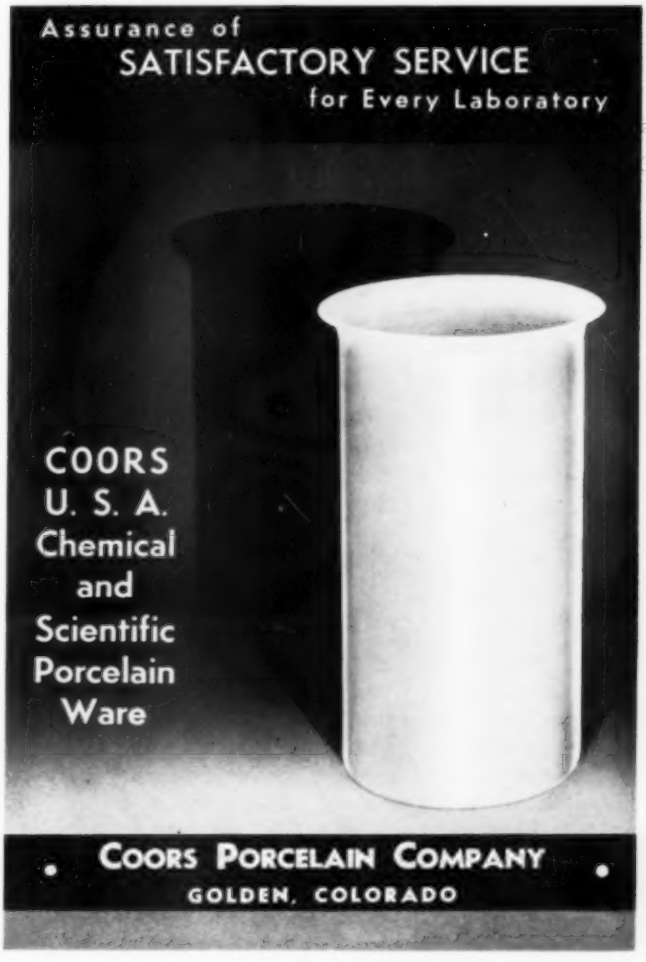
In his introduction, Dr. Victor C. Myers of Western Reserve University states that the present American edition will be a welcome addition to the textbooks on the subject available to teachers and students of biochemistry in this country. The reviewer believes this to be true, for in a comparatively small space, judged by similar American texts, Dr. Fearon has presented the essential and basic facts of animal biochemistry as well as the necessary facts of pure chemistry. The manner of presentation is simple, direct and clear. A considerable number of general references are given at the end of each chapter. J.F.M.

Desert Wild Flowers

By EDMUND C. JAEGER. Stanford University Press, Stanford University, California. 1940. xii + 322 pp. $3.50

This book, which is said to be the most complete work ever published on the flora of America's great southwestern deserts, is a collection of plant sketches and descriptions made by the writer during twenty-five years of desert trekking. Some 764 plants are described and illustrated by photographs or line drawings. A number of rare plants are included for which illustrations are seldom found either in popular or scientific literature. Some of the drawings are printed on special paper that will permit the interested botanist to color them as he observes the plants in the field. Since the book is intended as a field reference, brevity of description is to be expected. Short accounts are given of more than 150 desert explorers whose scientific studies are commemorated in the names of the plants mentioned. The book is enriched by observations on the bird, insect, and mammalian life associated with the desert plants.

Desert Wild Flowers will be of interest not only to professional botanists and to trained amateurs, but also to travelers and others who spend a good portion of their time outdoors. E.V.



A Calendar

Continued from Page One Hundred and Eight

JANUARY

PLANT OPPORTUNITIES

Trees: Pine, Spruce, Hemlock, Fir, Holly.
Plants: Mistletoe, Laurel, Poinsettia, Fern.

Study Suggestions: Observe size, shape, bark, of Christmas trees seen during the holiday season. Learn to recognize the pine, the hemlock, the spruce. Which were used around the Crib and the altar in Church? Bring small branches to the laboratory. Note the needles; how do they differ on the various evergreens? Sketch the arrangement of branches of different species; detect the difference of odor; examine for gum or resin. How old is the tree? Examine the rings in the cross section cut of the tree. Where does holly grow? Is it a bush or a tree? Examine the berries; the waxy leaves; venation; arrangement. Mistletoe is a parasite; it is widely distributed in warm parts of the old world. Frugivorous birds wipe their sticky beaks, to which seeds adhere, on tree bark where the seeds germinate. The American mistletoe is similar; it is found from central New Jersey to Missouri and southward to Florida, Texas, and New Mexico. It grows on oak trees, orchard trees, particularly apple trees. It is the state flower of Oklahoma.

Examine Laurel: size, shape, and arrangement of leaves. Where does it grow? When does it bloom? Is it an evergreen? State flower of Pennsylvania.

Cut poinsettias near to the ground after blooms fall; observe them grow again from the roots.

Ferns

"Living material of all stages is easily kept in the laboratory all year around.

"During the dormant season of winter, pieces of the rhizome with growing tips and buds can be brought in and planted.

"Spores can be gathered and the plants raised from prothallia."

(Turtox)

Ripe spores can be obtained from greenhouses at any time in the year.

Look for prothallia at the base of plants in pots.

Sow spores on the outside of a porous flower pot that has been immersed in water and filled with spagnum. Invert the flower pot with the spagnum and pores clinging to the outside, in a pan of water. Place under an inverted bell jar and watch for the development of prothallia.

Observe the life cycle: (1) Portion of leaf, sporophyte generation; (2) Sori with sporangia; (3) palisade layer; (4) sporangium; (5) indusium; (6) spore; (7) gametophyte; (8) gametophyte; (9) archegonia; (10) antheridia; (11) rhizoids; (12) sperm; (13) egg; (14) zygote; (15) young sporophyte produced by germinating zygote.

(Life cycle taken from *Turtox.)*

FEBRUARY

Mature Ferns

Varieties: Dagger Fern, known as Christmas Fern; Maidenhair Fern; Spleenwort; Holly-fern; Cretan-Brake; Spider-Brake; Boston Fern.

Study Suggestions: Examine and identify: (1) Rootstock or rhizome, the creeping stem, often underground; (2) Frond, the name applied to the leaf of a fern; (3) Stipe, the leaf stalk; (4) Blade, the expanded portion of the leaf; (5) Leaflets, the small segments or divisions of the leaves, often called pinnae; (6) Sori, the spots or dots on the leaves, where the sporangia are developed; (7) Indusium, the cover which in many species is developed over the sorus; (8) Ring or annulus, the row of thick-walled cells developed in the spore case of most ferns; (9) Fibro-vascular bundles, threads of specialized cells which extend throughout the plant body; (10) Sclerenchyma, thick-walled, rigid tissue; (11) Parenchyma, thick-walled undifferentiated tissue, or ground tissue; (12) Tracheids, large thick-walled empty cells in the fibro-vascular bundles; (13) Xylem or wood, the tracheids and the small thick-walled cells which the tracheids surround; (14) Bast or phloem, the soft thin-walled tissue around the wood; (15) Phloem sheath, the layer or cylinder of cells around the phloem; (16) Bundle sheath, the cylinder of cells around the phloem sheath; (17) Stomata, the pores opening through the epidermis; (18) Guard cells, the two cells surrounding the stomata; (19) Mesophyll, the green parenchyma cells which are arranged in a firm, regular layer; (20) Prothallia, the small gametophytes.

Collection Material

Varieties: Skunk cabbage; elm twigs, cottonwood, willow twigs, horsechestnut buds, mosses.

Study Suggestions: Skunk cabbage begins to show in many places through the snow. It is a good illustration of plants that send up a spathe in the initial stage of growth. Note its cowl-shape, its disgusting odor; its brownish-purple hue. Elm twigs, Cottonwood, Willow twigs, and Horsechestnut buds can now be obtained, brought into the laboratory, and there observed as they develop.

Twigs cut from the same tree about a week apart from now until the foliage is fully grown in late Spring is an interesting means of learning something about plant growth.

Mosses at this season develop reproductive organs, and can be studied if brought into the laboratory and placed in a terrarium.

MARCH - APRIL

Collection Material

Varieties: Masses of spotted salamander eggs; noisy peeper eggs; Bees; Flies; Cabbage Butterflies; patches of bloodroot flowers; Scarlet Cup Fungus; buds of various kinds; Frogs' Eggs; Toads' Eggs; the Walking Stick; the Praying Mantis; Grasshoppers; Blow Flies; Mosquitoes; Ants; Bees; Wasps; Hornets.

Study Suggestions: Obtain masses of salamander eggs; place them in battery jar to develop in the laboratory. In another container, place frog eggs, and in a third, toad eggs. Compare the appearance of the various eggs and tadpoles as they hatch and grow. The blow-fly is excellent material for study of metamorphosis. Observe its complete life cycle in a few days.

Walking Stick eggs and Praying Mantis eggs placed in terraria earlier in the year will hatch about this season. Compare the metamorphosis of each. Watch the walking sticks feed upon the grass and clover planted in the terrarium; provide the praying mantis with bits of liver or insects and observe him eat. Grasshoppers can be placed in a screened cage, in the bottom of which is several inches of loam planted with grass or wheat. The entire life cycle can be watched as it progresses from egg to adult, as also grasshopper behavior.

Bring to the laboratory a container of stagnant water from a rain barrel or a puddle. Examine it for wrigglers. Note how they come to the surface to breathe.

Plant Study

Materials: Leaves; Roots; Buds; Twigs; Bulbs; Tubers; Flowers.

Study Suggestions: Collect leaves from the same tree at short intervals over the period covered from the opening of the bud to the full growth of the leaf. Each student should select a different kind of tree. Press the leaves, mount them on charts, carefully labeling each and marking down the date of collection. Obtain a number of roots of wild flowers and weeds as the plants appear in early Spring—dandelion, violet, crocus, plantain.

Plant such bulbs and tubers in crocks as will furnish experiment material in growth in a short time—onion, potato, sweet potato—paper hyacinth. Make up nutrient solutions from formulae and plant wheat, corn, rye, buckwheat, etc., in sand, placing the wire container that holds the sand and seeds over the solution. Watch the root development as they grow down through the wire into the solution. Study root hairs; root tips. Compare various roots.

76890

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CENTRAL SCIENTIFIC COMPANY

SCIENTIFIC INSTRUMENTS CENCO LABORATORY APPARATUS

1700 IRVING PARK BOULEVARD, CHICAGO, ILL.

Silvering Glass

Continued from Page Ninety-nine

as a chemically clean surface absolutely free from dust or scum is essential for good results.

Procedure. Place on a table an old blanket or bath towel to catch any overflow. Lay the glass plate on this cloth. If the table is not level use wedges so that the glass surface will be even enough to hold the solution. As the reaction is very fast, do not mix solutions No. 1 and No. 2 before the glass is cleaned and ready for silvering. Measure out 14.1 ml. of No. 1 into a liter beaker, and add 14.1 ml. of No. 2. Add, while stirring, 480 ml. of distilled water and pour on the glass at once. The reaction begins promptly and deposition is complete in about one-half hour. Do not allow it to stand for any considerable period of time, even over night. Rinse well with tap water, flushing the spent chemicals down the drain. Rinse with distilled water, then with alcohol, and stand on edge to dry. If a flask, invert it.

A second deposit may be made upon the first if a heavier coating is needed. When the surface is dry it may be polished with a little chamois pad of rouge, using very light strokes with a circular motion. Coat with shellac, and paint with varnish or mirror paint, or both. ●

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[8]Silverman, A., and Howe, R. M., "The Deposition of Silver Films on Glass," Jour. Ind. Eng. Chem. 9, 1032, 1917.

[9]The solutions described here are from the Hubbuch Glass Company, Chattanooga, Tenn., by permission.

Quaint Gardens Recall Old Time Uses of Herbs

Exerting an interest over the early colonists comparable to that radiating today from seed catalogs was a manual on garden planting published in England in 1629, and entitled *Parkinson's Paradise.*

Gardens of the first settlers were not only provisions against famine, but family medicine closets. Among the herbs specially represented by Parkinson for medicinal use were "Lavandula, basil, marjoram, thyme, hyssop, pennyroyal, sage, mint, tansy and burnet." Sages, associated today with seasoning, were recommended for "gargles and mouth washes." Mint, "applied with salt is a good help," according to Parkinson, "for the biting of a mad dog." The physical properties of basil are "to procure a cheerful and merry heart, whereunto the seed is chiefly used in powder."

At the two national historical parks at Colonial, Virginia, and Morristown, New Jersey, as well as at George Washington Birthplace National Monument, Wakefield, Virginia, many of these interesting herbs are being cultivated in quaint oldfashioned gardens.

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Ancient Timbers

Continued from Page Ninety-six

disfigure or weaken the beams. He must also record carefully the room or rooms from which the various specimens have been taken, for this is important as will presently be seen.

During the excavation of this cliff pueblo one room is encountered which has been destroyed by fire. This fire burned fiercely until the roof was so weakened that it collapsed, smothering the blaze and converting the glowing roof beams to charcoal. Charcoal, although fragile, is almost indestructible even though submerged in water, and in it are preserved the annual growth rings of the tree in the same pattern of large and small as in normal wood. These bits of charcoal the archaeologist carefully preserves and packs with his collection of sound wood.

After the laboratory analysis a story can be told of the cliff ruin which could never be regained by other means. By matching the ring patterns of the specimens collected against the tree-ring calendar rooted in living trees of our time, the archaeologist knows that his sixty-room cliff pueblo was constructed in the short span of time between 1325 and 1350 A.D.; that, in one instance where three logs supported a roof, those three trees were cut in the same year; and that the second story rooms in all cases dated later than the first story rooms on which they were supported. In one or two instances a room had timbers of which the dates did not agree. Most of the beams indicated simultaneous cutting but one or two logs indicated a cutting of some fifty years earlier. Disconcerting though this situation may seem at first, it reflects a human trait which is to be seen even today—the salvaging of old material for re-use in new structures. The ancient timbers in this cliff pueblo thus yielded a chronicle of construction which is nearly as complete as it might have been had the builders kept a written record and filed it away in the cornerstone of the building.

As already implied, the objectives at the beginning of Dr. Douglass' study had nothing whatsoever to do with archaeology. But as time went on, this angle became increasingly important. So much so, in fact, that the National Geographic Society saw fit to co-operate by making it possible to send no less than three expeditions to various points in Arizona specifically to collect prehistoric wood from ruins. During the course of these undertakings many thousands of specimens were gathered and, on the framework provided by these, strengthened by many other collections of beam material made more recently in excavations by various institutions, has grown the present tree-ring calendar of nearly two thousand years' duration. The advantage this has given the archaeologist in his studies of bygone peoples cannot be adequately expressed in a few words.

For one thing we have a far more accurate knowledge of the time needed to bring about certain of man's developments in the Southwest than we had previous to

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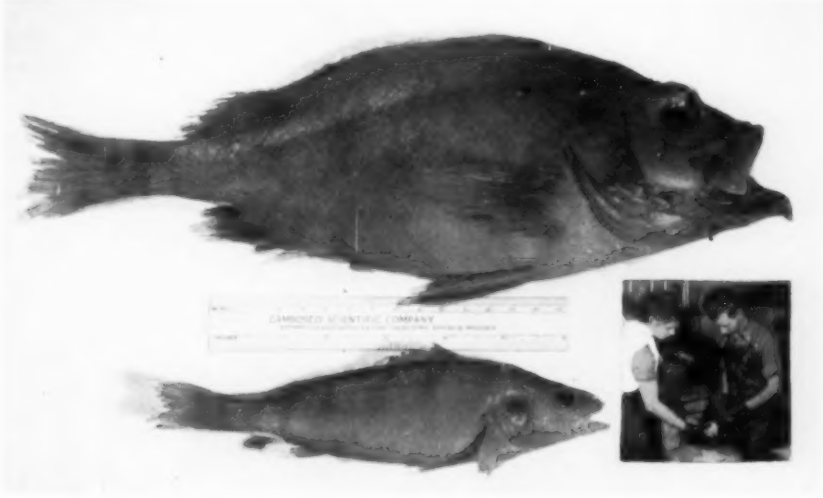

Above: A typical specimen of Sebastes marinus.
Below: A common perch of the size sold as "large".
Insert: Injection of Marine Bream at CAMBOSCO.

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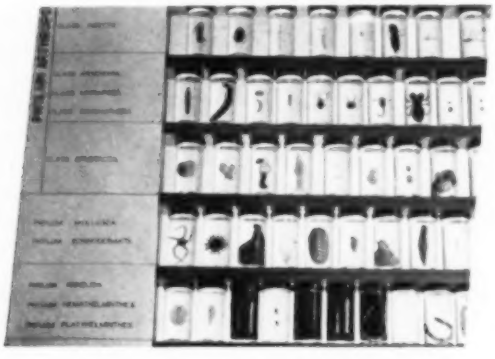
this discovery. Formerly it was believed that the oldest cave residents of the Four Corners area, that region where Arizona, New Mexico, Colorado, and Utah meet at a common point, dated from 1,000 to 3,000 years before Christ. Tree-rings have demanded a revision of this guess, and it can now be said with reasonable security that these cave remains must be dated in the early centuries after Christ. This has called for a general collapsing of all the developmental periods of the pueblo people into the fifteen hundred or so years since the time of these cave dwellers, commonly known as Basketmakers.

The rise of the pueblo people may now be traced from century to century, and we can say approximately when various additions were made to bring this civilization up to what it is today. One of the most interesting angles is the development of the communal type of house, rising story upon story, the rooms packed together bee-hive fashion. This type of architecture has no parallel in North America and it stands out as one of the unique contributions of native Americans which has materially influenced our own architectural styles in parts of the Southwest. One might suppose that the development from a subterranean room, widely used in the early centuries after Christ, to a four-storied dwelling with as many as five hundred rooms on the ground floor, required a very long period of time. Indeed this was the idea before tree-rings showed the situation to be otherwise. We know now, however, that within the brief span of two hundred to two hundred fifty years the architectural evolution was very rapid, going from one extreme to the other. Tree-rings alone have made an understanding of this phenomenal change clear. On the other hand, we can also see that certain traits were comparatively stable over long periods of time. The subterranean ceremonial room, otherwise known as the *Kiva*, is found repeatedly in ruins dating from more than a thousand years ago. These kivas exist in modern pueblos even today with only minor changes, having survived through the centuries, owing to a conservatism which so frequently goes with religion.

Dating by tree-rings cannot be accomplished in all quarters of the Southwest since much of this area is semi-arid and lacks the useful trees which occur in the higher elevations. The area where this means of computing time has been most successfully employed can be enclosed by drawing a line on a map from Mesa Verde in southwestern Colorado west through southern Utah, south along the Grand Canyon, then in a southeasterly direction approximately to Globe, Arizona, thence east into New Mexico, following north through the central section of that State, and finally back to Mesa Verde, now preserved as Mesa Verde National Park. Beyond these limits, however, there are abundant evidences of prehistoric people whose remains the archaeologist is equally anxious to date. This can be done in many instances by the discovery, let us say, of clay vessels in southern Arizona, originally made in the Flagstaff area,



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where tree-ring dates apply. The inference is, in this case, that this alien vessel of known age occurring with the remains of desert dwellers can be used in a rough way to indicate the age of those people. Hence tree-ring dating becomes indirectly effective even in those areas which lie beyond the limits where it is now successfully practiced.

This is but one of several useful angles which has grown out of tree-ring dating research. How far this science will go no one can predict as yet. But the accomplishments up to the present time have so far exceeded the fondest hopes of Dr. Douglass and his students that, even if further success does not come, the results have amply justified the energy which has been spent. ●

Aluminum Alloys

Continued from Page Ninety-eight

aging. While the older models are heated in an oven, the newer ones have an electrical heating coil in the center of the form.

When it is finished by the Alzak process, aluminum reflects as much as 85 per cent of the light falling on its surface and provides a good reflector material for the lighting industry. Such reflectors are well suited to the new fluorescent lighting, for which it is readily made into efficient trough-like reflectors. Alzak reflectors are also used in almost all major league baseball parks.

Though it conducts heat well, aluminum is also an excellent reflector of radiant heat, and finds use in insulation, reflectors for radiant drying, and paint for roofs of buildings. The weight of aluminum foil insulation in a van type meat truck is only 30 pounds as against 2,000 pounds for even the lightest weight bulk insulation.

While aluminum is an important part of an alloy which makes possible the world's strongest magnets, the metal itself is non-magnetic. Pilot houses and other metallic parts within the so-called "magnetic circle" must be non-magnetic, and aluminum offers not only this property, but a favorable strength-weight ratio and stability in a marine atmosphere.

In almost every home in America, you will find aluminum cooking utensils. The use of such utensils by leading hospitals, restaurants and governmental agencies—and the tests of research men—attest to its non-toxicity. It has been estimated that nearly 500 million pots and pans have been made since the industry began. The last few years have seen the restyling of many utensils for beauty and the housewife's convenience.

The food friendliness of aluminum has made it a leading packaging material—for caps and seals in food; cosmetic and drug industries; and for foil wrapping that keeps cheese, tea, coffee and similar items fresh and healthful.

Heat sealing, which has recently been adapted to aluminum foil for the first time, offers more efficient packaging for such products as foods, drugs and tobacco. The process provides a completely hermetic seal,

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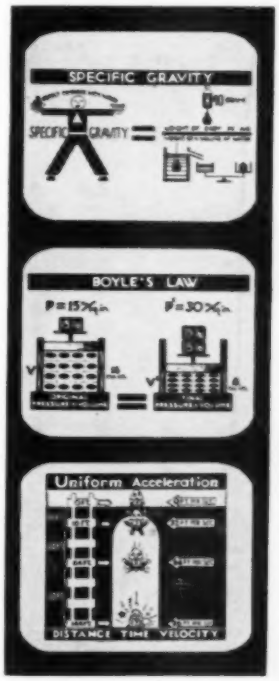

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Progress has been made in developing a wide range of natural and colored finishes for aluminum for use in such widely different fields as architecture, consumer goods, furniture, transportation, paint, jewelry and novelties and packaging. The jewelry and novelty line furnished one of aluminum's first outlets, and there is now increased activity in this field. Among the items in this line are aluminum mesh bags, beads, vanity cases, cigarette cases and bracelets.

Underlying all the useful qualities mentioned is the ease with which aluminum is fabricated into all forms in which metals are produced. One of the most workable of metals, aluminum saves money because of the ease with which it is formed, cast, riveted and welded. It was not so long ago that methods for electric resistance welding were first developed for aluminum. Now, it is possible to join thin gauges of aluminum sheet neatly and economically by means of brazing. The new process is adapted to such products as outboard motor gasoline tanks, refrigerator shelves, finned sheet parts, and other light metal assemblies where gas or arc welding would be impossible.

Much of the progress in the aluminum industry can be traced to research. It was by research (in a woodshed to be sure) that 22-year-old Charles Martin Hall discovered the electrolytic process that was the beginning of the aluminum industry as we know it today. It was by research, too, that Wilm of Germany discovered shortly before the World War the duralumin type alloys which have remarkably high strengths. Therefore, it is not surprising that the industry should spend millions of dollars for research facilities to improve old alloys and develop new ones, and to lay the foundation for modern design and fabrication practices.

The newest addition to the Aluminum Research Laboratories, New Kensington, Pennsylvania, is the world's most powerful testing machine. It is capable of exerting a force of 3,000,000 pounds in compression and 1,000,000 pounds in tension. The importance of so large a machine lies in the fact that it will test a complete structure and not just sections of it. While it will measure gigantic forces accurately, it is yet so sensitive it can crack a watch crystal without stopping or damaging the works. Tests are being made for the purpose of advancing aluminum's usefulness for heavy duty equipment, railroad cars and airplanes.

The aluminum industry believes in research as a key to the future. Though it has had a remarkable past, and accomplished in the short space of 50 years what for other metals required centuries, it does not look backward, but forward—forward to another half century equally beneficial to mankind! ●

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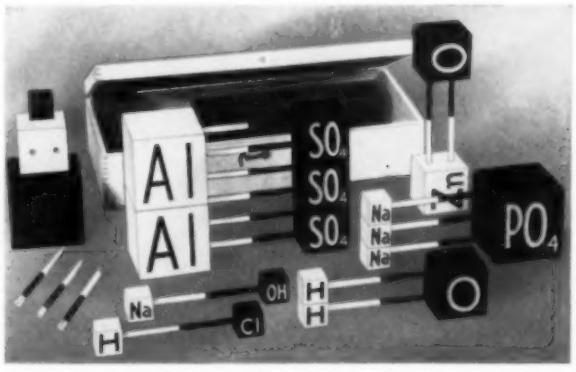

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The Bulletin Board

Continued from Page Ninety-four

The student who wrote the historical note pointed out the importance of copper to ancient peoples. He illustrated his section with pictures of copper utensils, tools and weapons. The student who prepared the section on occurrence of copper traced small hemisphere maps to show locations of deposits. Pictures of mining and specimens of ore were used. A description of the manufacturing processes was written and illustrated by action pictures of a blast furnace and the open hearth type of furnace where poling was being carried out. A small oak stick was labeled: "Wood used in poling." An outline map of the local area showing the location of copper manufacturing plants was placed under the theme section. One of the remaining sections featured the use of copper in electrical equipment. A second showed how copper is employed in the home. A third showed various types of copper tubing and wire. A fourth depicted various alloys of copper. A miscellaneous section indicated how copper is used to coat bullets and how copper compounds are used in insecticides.

In preparing the different sections, our students used specimens and samples when they were available. Pictures, photographs, sketches, models and typewritten descriptions were used when necessary to tell the story. A fruitful source of illustrations is advertisements of the substance being depicted. Mail order catalogues contain many pictures of tools and household articles which can be employed.

This method can be used with excellent results to stimulate interest in current science literature. It requires considerable time for successful development. The instructor should urge the students to bring in all the articles that they encounter dealing with the science being studied. The article is dated and autographed by the student clipping it. It is brought in and used in class if feasible, or immediately posted for a week on a small bulletin board. It is then filed for future use. After sufficient clippings have been collected, they are classified into groups treating such fields as medicine, metals, fuels, atomic structure, etc. Volunteers are requested to develop these sections. The students proceed to read the articles and underline with a colored pencil the most important sentence or paragraph in each article. The articles are arranged in logical sequence in each section. The sections are arranged on the board in the most attractive manner. After a few weeks the clippings are filed or put in a scrapbook. This method is certain to stimulate interest in current literature. It usually results in an interesting bulletin board also.

Cellulose, a topic which is frequently neglected, was developed into a very interesting student activity. The theme section indicated by equation that carbon dioxide and water unite to form cellulose. A student artist drew above the arrow a picture of a tree with green leaves on which sunlight was falling. Underneath was written in inch-high letters the caption: "Nature's basic reaction." Sections presented cellulose as building material, rayon, linen, cotton, film, explosive, lacquers and cattle food. Pictures and samples were used in profusion. A very attractive board resulted.

Some of the best displays should be saved and placed on the board at the beginning of the term before the incoming students have had an opportunity to prepare a topic. Some of them will prove good enough for use as visual material for classroom use.

This method of handling the bulletin board is a good one because it helps to motivate the students. It stimulates the pupils who participate to study the topic more thoroughly. Display of student work tends to produce friendly rivalry. It arouses general interest in the student body because of the natural inclination to examine the work of friends or acquaintances. It places the material presented by the bulletin board at the student level. Excellent displays are produced without overburdening either students or instructor. Several topics can be presented each term if careful advance plans are made. ●

The Fig

Continued from Page One Hundred

on a commercial scale in California in 1860. It is significant that it was the Smyrna fig which was introduced. Realization of the need for the capri fig and the fig wasp brought about a satisfactory solution when Swin-

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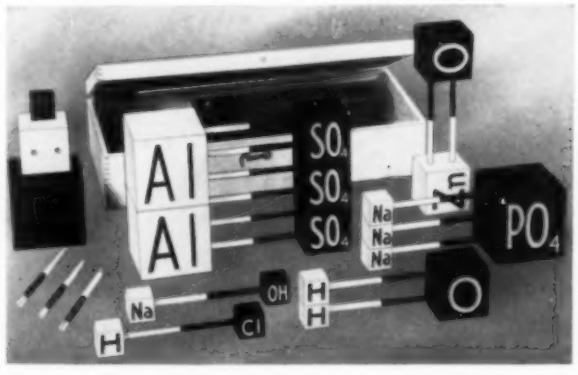

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The Bulletin Board

Continued from Page Ninety-four

The student who wrote the historical note pointed out the importance of copper to ancient peoples. He illustrated his section with pictures of copper utensils, tools and weapons. The student who prepared the section on occurrence of copper traced small hemisphere maps to show locations of deposits. Pictures of mining and specimens of ore were used. A description of the manufacturing processes was written and illustrated by action pictures of a blast furnace and the open hearth type of furnace where poling was being carried out. A small oak stick was labeled: "Wood used in poling." An outline map of the local area showing the location of copper manufacturing plants was placed under the theme section. One of the remaining sections featured the use of copper in electrical equipment. A second showed how copper is employed in the home. A third showed various types of copper tubing and wire. A fourth depicted various alloys of copper. A miscellaneous section indicated how copper is used to coat bullets and how copper compounds are used in insecticides.

In preparing the different sections, our students used specimens and samples when they were available. Pictures, photographs, sketches, models and typewritten descriptions were used when necessary to tell the story. A fruitful source of illustrations is advertisements of the substance being depicted. Mail order catalogues contain many pictures of tools and household articles which can be employed.

This method can be used with excellent results to stimulate interest in current science literature. It requires considerable time for successful development. The instructor should urge the students to bring in all the articles that they encounter dealing with the science being studied. The article is dated and autographed by the student clipping it. It is brought in and used in class if feasible, or immediately posted for a week on a small bulletin board. It is then filed for future use. After sufficient clippings have been collected, they are classified into groups treating such fields as medicine, metals, fuels, atomic structure, etc. Volunteers are requested to develop these sections. The students proceed to read the articles and underline with a colored pencil the most important sentence or paragraph in each article. The articles are arranged in logical sequence in each section. The sections are arranged on the board in the most attractive manner. After a few weeks the clippings are filed or put in a scrapbook. This method is certain to stimulate interest in current literature. It usually results in an interesting bulletin board also.

Cellulose, a topic which is frequently neglected, was developed into a very interesting student activity. The theme section indicated by equation that carbon dioxide and water unite to form cellulose. A student artist drew above the arrow a picture of a tree with green leaves on which sunlight was falling. Underneath was written in inch-high letters the caption: "Nature's basic reaction." Sections presented cellulose as building material, rayon, linen, cotton, film, explosive, lacquers and cattle food. Pictures and samples were used in profusion. A very attractive board resulted.

Some of the best displays should be saved and placed on the board at the beginning of the term before the incoming students have had an opportunity to prepare a topic. Some of them will prove good enough for use as visual material for classroom use.

This method of handling the bulletin board is a good one because it helps to motivate the students. It stimulates the pupils who participate to study the topic more thoroughly. Display of student work tends to produce friendly rivalry. It arouses general interest in the student body because of the natural inclination to examine the work of friends or acquaintances. It places the material presented by the bulletin board at the student level. Excellent displays are produced without overburdening either students or instructor. Several topics can be presented each term if careful advance plans are made. ●

The Fig

Continued from Page One Hundred

on a commercial scale in California in 1860. It is significant that it was the Smyrna fig which was introduced. Realization of the need for the capri fig and the fig wasp brought about a satisfactory solution when Swin-

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gle, in 1899, succeeded in bringing in the winter generation, the mamme, from the Mediterranean. The question arises as to the apparent irreconcilability of the data just presented. It should be pointed out that all figs of the Smyrna variety bear seeds and must be pollinated. In most other edible varieties only mule flowers are present. These varieties are parthenocarpic and produce the swollen receptacle without pollination.

Although attempts at cultivation have posed many problems, there is little question of the significance of the fig from the standpoint of food value. The seed of the dried Smyrna fig contains oil. Incidentally the parthenocarpic, seedless syconia do not preserve well and are not dried. Dried figs contain traces of copper, zinc, and iron. Ash content ranges from 29-36 grams per kilogram; potassium from 10-18 grams per kilogram; calcium about 3 grams per kilogram.

The fig, precious food of the ancients and welcome addition to the table of moderns, has had a long and honorable career since the first succulent syconium was eaten and found good. ●

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